AAF Technical Report 5568

TEST OF TWO CUSTER CHANNEL WINGS HAVING A DIAMETER OF 37.2 INCHES AND LENGTHS OF 43 AND 17.5 INCHES

(Five-Foot Wind Tunnel Test No. 545)

ARMY AIR FORCES

AIR MATERIEL COMMAND

Wright Field Dayton, Ohio

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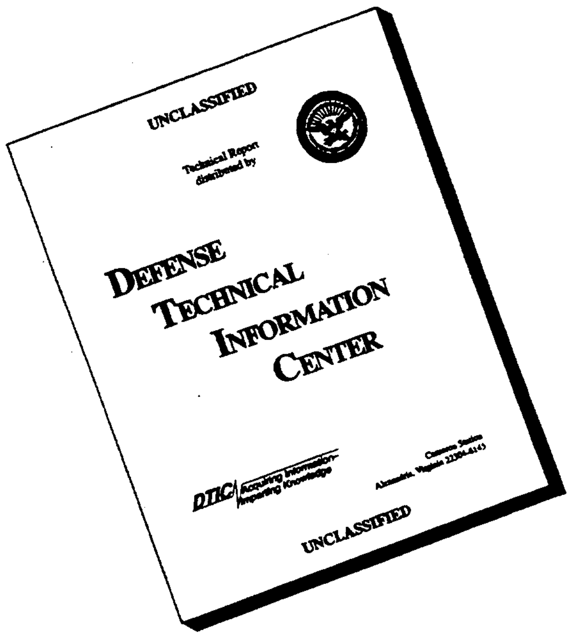

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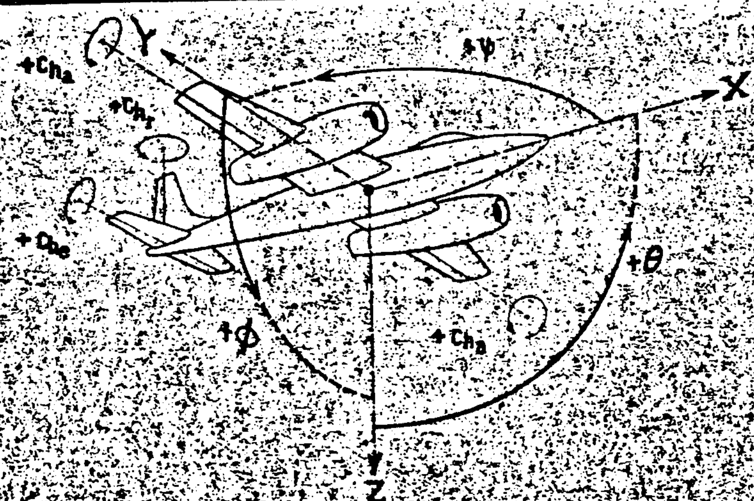

NOTE: Plus signs refer to the hinge moments resulting from the airloads.

Positive direction of control surfaces: is the same as for positive hinge moments, i. e.:

- Aileron and tab attached, trailing edge below neutral position;
- Stabilizer, elevator, and tab attached, trailing edge below neutral position;
- Fin, rudder, and tab attached, trailing edge to left.

Terminology for Airplane Axes

Wind, or tunnel, axes: A system of axes in which the X axis always points along the relative wind, the Z axis lies in a vertical plane containing the X axis and is perpendicular to the X axis, and the Y axis is perpendicular to both the X and Z axes.

Stability axes: A system of axes in which the X axis is the intersection of the plane of symmetry of the airplane with a plane perpendicular to the plane of symmetry and parallel to the relative wind direction. The Y axis is perpendicular to the plane of symmetry, and the Z axis is in the plane of symmetry and perpendicular to the X axis.

Forces and Moments

AXIS		FORCE PARALLEL TO AXIS		MOMENT ABOUT AXIS			ANGLE		VELOCITY	
		SYMBOL								
Designation	Symbol	Aerodynamic	Stability	Designation	Symbol	Positive Direction	Designation	Symbol	Linear Component Along Axis	Angular
Longitudinal	X	D	X	Rolling	L	Depresses right wing	Roll	ϕ	u	p
Lateral	Y	Y	Y	Pitching	M	Depresses tail	Pitch	θ	v	q
Normal	Z	L	Z	Yawing	N	Retards right wing	Yaw	ψ	w	r

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WAR DEPARTMENT
ARMY AIR FORCES
AIR MATERIEL COMMAND
DAYTON, OHIO

AAF TECHNICAL REPORT
NO. 5568

TEST OF TWO CUSTER CHANNEL WINGS HAVING A DIAMETER OF 37.2 INCHES AND LENGTHS OF 43 AND 17.5 INCHES

(FIVE-FOOT WIND TUNNEL TEST NO. 545)

By

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TEST OF TWO CUSTER CHANNEL WINGS HAVING A DIAMETER OF 37.2 INCHES AND LENGTHS OF 43 AND 17.5 INCHES

SUMMARY

The Custer Channel Wing is a wing-propeller arrangement designed to produce lift statically or to augment the normal lift when the vehicle has some forward velocity.

Flight tests of an airplane incorporating two of these channel wings were conducted first by the inventor.

The next test (ref. 1) was conducted by the Air Materiel Command in the Five-Foot Wind Tunnel on a 1/3-scale powered model of one channel. Additional static lift tests of this same model but with additional improvements were made by the inventor and witnessed by an Air Materiel Command representative. These results are reported in reference 2.

The last series of tests are those described in this report. Up to the time of this present series of tests both model and full scale tests of this arrangement were made under conditions which did not give accurate power input and thrust data. In this series of tests made on a 1/2-scale model, all variables such as lift, drag and thrust combination, pitching moment, power input and pressure distribution have been accurately obtained.

These tests which included 53 different model configurations were made on two different length channels, with two and three blade propellers of various planforms and blade angles. Tests were also made to determine the effect of placing auxiliary wings of various sizes and arrangements aft of the propeller-wing combination.

The results of these tests indicated the short channel was superior to the long channel in that the resultant of the thrust and lift forces was greater than for the long channel. In addition the pressure distribution over the short channel is more desirable than over the long channel.

The propeller which had a normal blade planform was slightly better than the one in which the blade planform had a reverse taper.

End plates mounted on the sides of the long channel were beneficial but not on the short one.

The general effect of auxiliary wings aft of the channel was to increase lift and decrease thrust in such a way that there was no net gain as regards resultant force. However, the direction of the resultant force is closer to vertical and hence would require smaller ground angles for vertical ascents. The deflection of auxiliary wings aft of the channel also causes a large diving moment that probably would be undesirable.

DATES AND PLACE OF TESTS

These tests were conducted in the Five-Foot Wind Tunnel at Wright Field from 6 February to 22 May 1946.

OBJECT

The object of this test was to determine the resultant force in pounds/HP obtainable with Custer Channel Wing.

DESCRIPTION OF MODEL AND BALANCE SET-UP

The long channel used a Clark Y airfoil of 43-inch chord whose chord plane coincided with a half cylinder of 18-5/8 inches radius. Short wing sections of the same airfoil shape and chord were attached to the sides of the channel to form a U-shaped wing. The overall span was 72 inches. The short channel (17.5-inch chord) had the same radius but was not fitted with stub wings. Sketch No. 1 on page 49 shows the shape of the airfoil used on the short channel. The shape of the 25-inch chord auxiliary wing approximated an NACA 6309 section. Both sets of auxiliary wings were parted at the center line of the model so that the right and left halves could be set at different angles of incidence. The two methods of mounting are shown on photograph 208379. The plate was attached to the end of the wing while the angle bracket was attached to the upper surface of the wing. Both plates and brackets were in place when the above photograph was taken in order to show both attachments.

The propeller was mounted to a shaft which was supported at two positions by combination radial thrust bearings. These bearings were supported by 1-inch diameter steel rods which extended from the center of the channel to the wing tips, see photograph 208384. The propeller shaft was connected to the propeller balance shaft by means of a jack shaft which had a universal joint at either end. This provided the channel with freedom of movement vertically, so that the lift forces could be measured. This shafting assembly transmitted the torque and thrust from the channel to the propeller balance, where each was measured. A tension cable was used to reduce the weight of the channel wing on the lift scales and also to place the jack shaft in tension under all loading conditions. The lift forces were transmitted to the two lift balances by means of the tubular structure shown on photograph 208384. The attachment of these tubular structures to the channel wing was made by self aligning ball bearing assemblies and to the balance platform by means of universal joints. The model was restrained in yaw and side movement by means of a single steel ball, mounted at the top of each of four uprights shown in photograph 208384. These balls slid against a steel plate attached to the wing stubs at each corner of the wing assembly. Thus the model was restrained in yaw and side direction but free to move vertically or horizontally. Safety stops were provided inevent of failure of any of the balance structure.

Pressure orifices were provided on the inner surface in the plane of symmetry at every 5 percent station of both short and long channels. Photograph 208373 shows the pressure distribution set up for the long channel.

The 53 different model configurations are tabularated below:

LIST OF MODEL CONFIGURATIONS

CUSTER CHANNEL WING

Condition No.	Channel Length Inches	Channel End Plates	Propeller No. (1)	Blade Angle° At % Radius	Auxiliary Wing Chord	Auxiliary Wing Span	Auxiliary Wing Section	Auxiliary Wing (2) No. of Panels	Auxiliary Wing Position	Auxiliary Wing Angle	Auxiliary Wing Mounting Brkt	Auxiliary Wing Mounting Plate	Photograph Number
1	43	—	1	20-75	—	—	—	-	—	—	—	—	208376
2	43	—	-	—	—	—	—	-	—	—	—	—	—
3	43	—	2	20-75	—	—	—	-	—	—	—	—	208375&208383
4	43	—	-	—	—	—	—	-	—	—	—	—	—
5	43	—	2	20-75	—	—	—	-	—	—	—	ON	208380&208382
6	43	—	2	20-75	—	—	—	-	—	—	—	ON	—
7	43	—	2	20-75	25	36	4408	1	(3)	(3)	—	ON	—
8	43	—	2	20-75	25	69	4408	2	(3)	(3)	—	ON	—
9	43	—	2	20-75	25	69	4408	2	12-4	L 42.5 R 55.0	—	ON	—
10	43	—	2	20-75	25	69	4408	2	12-4	L 42.5 R 55.0	ON	—	—
11	43	ON	2	20-75	25	69	4408	2	12-4	L 42.5 R 55.0	ON	—	—
12	43	ON	2	20-75	15	56	6309	4	12-4	L 42.5 R 55.0	—	ON	208372& 208378
13	43	ON	3	8.6-90	—	—	—	-	—	—	ON	ON	208379&208381
14	43	ON	3	13.6-90	—	—	—	-	—	—	ON	ON	—
15	43	ON	3	3.6-90	—	—	—	-	—	—	ON	ON	—
16	43	ON	3	11.1-90	—	—	—	-	—	—	ON	ON	—
17	43	ON	2	20-75	—	—	—	-	—	—	ON	ON	—
18	43	ON	4	20-75	—	—	—	-	—	—	ON	ON	—
19	43	ON	-	—	—	—	—	-	—	—	—	—	—
20	43	ON	5	8.6-90	—	—	—	-	—	—	ON	ON	—

LIST OF MODEL CONFIGURATIONS CONT'D

Condition No.	Channel Length Inches	Channel End Plates	Propeller No. (1)	Blade Angle° At % Radius	Auxiliary Wing Chord	Auxiliary Wing Span	Auxiliary Wing Section	Auxiliary Wing (2) No. of Panels	Auxiliary Wing Position	Auxiliary Wing Angle	Auxiliary Wing Mounting Brkt	Auxiliary Wing Mounting Plate	Photograph Number
21	43	ON	5	8.6-90	15	56	6309	4	T 12-1 B 12-7	L 42.5 R 55.0	ON	ON	——
22	43	ON	5	8.6-90	15	56	6309	2	12-7	L 42.5 R 55.0	ON	ON	——
23	43	ON	2	20-75	15	56	6309	4	T 12-1 B 12-7	L 42.5 R 55.0	ON	ON	——
24	43	ON	2	20-75	15	56	6309	4	T 12-1 B 12-14	L 43.0 R 55.0	ON	ON	208374&208384
25	43	ON	2	20-75	—	—	——	-	——	——	ON	ON	208370&208371 208373
26	17.5	—	2	20-75	—	—	——	-	——	——	—	—	——
27	17.5	ON	2	20-75	—	—	——	-	——	——	—	—	——
28	17.5	ON	2	20-75	15	56	6309	4	T 12-0 B 12-8	L 30 R 40	—	ON	——
29	17.5	ON	2	20-75	15	56	6309	4	T 12-0 B 12-8	L 25 R 40	—	ON	——
30	17.5	ON	2	20-75	15	56	6309	4	T-12-0 B 12-8	L 35 R 40	—	ON	——
31	17.5	ON	2	20-75	15	56	6309	4	T 12-0 B 12-8	L 35 R 50	—	ON	——
32	17.5	ON	2	20-75	15	56	6309	4	T 12-0 B 12-5	L 35 R 50	—	ON	——
33	17.5	ON	2	20-75	T-15(4) B-29	T-28 B-35	T-6309 B-4408	2	T 12-1 B 12-7	T 35 B 35	—	ON	——
34	17.5	ON	2	20-75	29 (5)	35.5	4408	1	12-7	40	—	ON	——
35	17.5	ON	5	8.6-90	—	—	——	-	——	——	—	—	——

LIST OF MODEL CONFIGURATIONS CONT'D

Condition No.	Channel Length Inches	Channel End Plates	Propeller No. (1)	Blade Angle° At % Radius	Auxiliary Wing Chord	Auxiliary Wing Span	Auxiliary Wing Section	Auxiliary Wing (2) No. of Panels	Auxiliary Wing Position	Auxiliary Wing Angle	Auxiliary Wing Mounting Brkt	Auxiliary Wing Mounting Plate	Photograph Number
36	17.5	ON	5	8.6-90	—	—	—	-	—	—	—	—	—
37	17.5	ON	5	8.6-90	—	—	—	-	—	—	—	—	—
38	17.5	ON	5	8.6-90	—	—	—	-	—	—	—	—	—
39	17.5	ON	5	11.1-90	—	—	—	-	—	—	—	—	—
40	—	—	5	11.1-90	—	—	—	-	—	—	—	—	—
41	—	—	5	21.1-90	—	—	—	-	—	—	—	—	—
42	—	—	5	31.1-90	—	—	—	-	—	—	—	—	—
43	—	—	5	6.0-90	—	—	—	-	—	—	—	—	—
44	—	—	2	20-75	—	—	—	-	—	—	—	—	—
45	—	—	6	8-75	—	—	—	-	—	—	—	—	—
46	—	—	5	11.1-90	—	—	—	-	—	—	—	—	—
47	—	—	5	21.1-90	—	—	—	-	—	—	—	—	—
48	—	—	5	16.1-90	—	—	—	-	—	—	—	—	—
49	—	—	5	16.1-90	—	—	—	-	—	—	—	—	—
50	—	—	5	16.1-90	—	—	—	-	—	—	—	—	209513&209514
51	—	—	5	11.1-90	—	—	—	-	—	—	—	—	—
52	—	—	5	11.1-90	—	—	—	-	—	—	—	—	—
53	17.5	—	6	8-75	—	—	—	-	—	—	—	—	211042 211043 211044

See Notes (1), (2), (3), (4) and (5) on following pages.

Note 1

Propeller No. 1 as shown on photograph 208374 was a three-blade adjustable-pitch type of metal construction. The blade planform was conventional and the tips were rounded.

Propeller No. 2 as shown on photograph 208375 was a two-blade, fixed-pitch type of wood construction. The airfoil section was the NACA 4400 series. The blade planform was conventional and the tips had a radius approximately equal to the radius of the channel.

Propeller No. 3 as shown on photograph 208379 was a three-blade, adjustable-pitch type of cast aluminum construction. The airfoil section was of the NACA 4400 series. The blade planform was unconventional in that it had reverse taper. The blade tips had a radius approximately equal to the radius of the channel.

Propeller No. 4 was very similar to No. 2 except for a thinner root section.

Propeller No. 5 was propeller No. 3 with the blades extended 0.5 inch. This permitted the propeller to be moved to the extreme aft position in the channel and still maintain small clearances with the inner surface of the channel.

Propeller No. 6 as shown on photograph 211042 was the same as propeller No. 2 except for blade angles. The 75 percent station was decreased from 20 to 8 degrees.

Note 2

The position of the auxiliary wings given in the table refer to the distance the axis of rotation or spar centerline was aft of the channel trailing edge and below the thrust centerline. For example, T 12-4 would mean the axis of rotation of the top auxiliary wing was 12 inches aft of the trailing edge and 4 inches below the thrust axis. The axis of rotation of the 25-inch chord wing was 6.10 inches aft of the leading edge and 1.03 inches above the chord plane. The axis of rotation of the 15-inch chord wing was 4.70 inches aft of the leading edge and .90 inches above the chord plane.

Note 3

Model condition 7 and 8 were run with several different settings of the auxiliary wing which were referred to as 7a, 7b, etc. The position and angles of the auxiliary wing were as follows:

7a	12-0	35°	7g	12-2	45°
7b	12-0	45°	7h	12-3	35°
7c	12-1	45°	7i	12-3	35°
7d	12-1	35°	7j	12-1	35°
7e	12-2	35°	7k	12-1	50°
7f	12-2	50°	7l	12-1	40°

		left	right			left	right
8a	12-2	15°	55°	8h	12-2	45°	55°
8b	12-2	15°	50°	8i	12-2	42.5	55°
8c	12-2	20°	55°	8j	12-2	42.5	60°
8d	12-2	25°	55°	8k	12-2	42.5	50°
8e	12-2	30°	55°	8l	12-2	42.5	55°
8f	12-2	35°	55°	8m	12-3	42.5	55°
8g	12-2	40°	55°	8n	12-4	42.5	55°

Note 4

Both top and bottom auxiliary wings were located in the left hand position.

Note 5

The one auxiliary wing was located in the left hand position.

PROCEDURE

The various model configurations were tested in the same order as the number given to the particular configuration. For any given condition, lift, (drag and thrust combination) pitching moment, torque and rpm were measured for a range of rpm from about 600 to 2800 in about 7 steps. The highest rpm in most cases represented a power input of about 10 HP. In some cases complete runs were not made. To obtain friction losses in the shafting, the propeller was removed and torque and rpm data were obtained. This procedure was followed at three different intervals of the test program. This loss in shafting represented about 5 percent of the gross power input. This loss was determined with and without a thrust load equal to that supplied by the propeller.

DISCUSSION OF RESULTS

The results of the test are given in tabular form on pages 12 to 22, due to the large number of model configurations. The data are also shown in graphical form on graphs 1 to 25. They have been separated into seven different groups for comparative purposes, and for simplification of the graphical presentation. The parameters used were the increment of force or moment per horsepower, absorbed by the propeller versus the horsepower divided by the square of the propeller diameter,(which is comparable to the unit disc loading).

The first group of conditions, 1, 3, 5, 18 and 20, plotted on graphs 1, 2, 3 and 4 shows the effect of different types of propellers and auxiliary wing mounting brackets. The results indicate that the two-blade propeller of conventional planform was the best in this grouping from the standpoint of thrust, lift and resultant force.

The second group of conditions, 7, 8, 9, 10 and 11, plotted on graphs 5, 6, 7 and 8 shows the effect of a simple auxiliary wing mounted aft of the channel at various positions and angles of incidence.

The third group of conditions, 13, 14, 15 and 16, plotted on graphs 9, 10, 11 and 12, shows the effect of changing the blade angle of the three-blade propeller which had a reverse taper, that is, wide tip and narrow root. Results of these tests indicate that an angle of 8.6 degrees at the 90 percent station is the optimum angle for this particular propeller.

The fourth group of conditions, 12, 21, 22, 23 and 24, plotted on graphs 13, 14, 15 and 16, shows the effect of various combinations of small-chord auxiliary wings and propellers. All of these conditions are inferior to the plain channel from the standpoint of resultant force. Although they do improve the lift force, it is at the expense of less thrust which is due to the blocking effect on the propeller and the drag of the auxiliary wings themselves.

The fifth group of conditions, 26, 27, 35, 37, 38 and 39, plotted on graphs 17, 18, 19 and 20 give the effect of a shorter channel with various propeller changes. This channel has a length of 17.5 inches compared to one of 43 inch length, used in all previous conditions.

The two-blade conventional planform propeller in conjunction with the short channel is superior to the other propellers which were tested. This is similar to the results of propeller dhanges made in conjunction with the long channel. The other conditions in this group were unsuccessful attempts to improve the propeller efficiencies by the use of spinners and hub fairings.

The sixth group of conditions, 28, 29, 30, 31, 32, 33 and 34, plotted on graphs 21, 22, 23 and 24 shows the effect the short chord auxiliary wings have on the characteristics when used in conjunction with the short channel. As was the case with the long channel, the auxiliary wings improve lift but decrease thrust. There was little or no gain in the resultant force.

The seventh group of conditions 40 through 52 and plotted on graph 25 were made without any channel. Only thrust and power input data were obtained. Here again the two-blade conventional planform propeller gave the greatest thrust per horsepower of all the propeller conditions that were tested.

The pressure distribution data for both the long and short channel is shown on graph 26. The important thing to note concerning the comparison of the two lengths of channels was that the negative pressure gradient increased with an increasing rate from the leading edge to the propeller disc, whereas the short channel had a more constant pressure over the entire length of the channel. By comparing these pressure gradients for the maximum slip condition, that is, full power and no forward velocity, with the condition of minimum slip, the effect of power on the pressure gradient should be much less for the short channel than for the long one. Therefore from the standpoint of change in trim of the aircraft with power, a design incorporating the short channel should have a distinct advantage over the long channel.

Auxiliary wings mounted aft of the channel do increase the lift.

force but they also decrease the thrust which results in about the same resultant force. They also cause a large diving moment which must be trimmed out by some means, probably by a negative tail load, if the tail is in the conventional position, thus resulting in a loss of lift.

CONCLUSIONS

1. The highest value of resultant force per horsepower obtained in these tests was 8.2. This corresponds to a value of horsepower divided by propeller diameter squared equal to one. (Condition No. 26)

2. The 17.5-inch chord channel was superior to the 43-inch chord channel as regards resultant force, moment and change in trim due to power change.

3. The auxiliary wings aft of the channel increase lift but decrease thrust, which results in no appreciable gain in resultant force.

4. The two-blade, conventional planform propeller was superior to the other types which were tested.

RECOMMENDATIONS

None

LIST OF REFERENCES

1. "Test of 1/3-Scale Powered Model of Custer Channel Shaped Wing" (Five-Foot Wind Tunnel Test No. 487), by D. W. Young, AAF Technical Report No. 5142.

2. "Custer U-Shaped Channel Wing" by D. W. Young, AAF Memorandum Report No. TSEAL-2-4586-3-2.

TABLE NO. 1

CUSTER CHANNEL WING

FIVE-FOOT WIND TUNNEL TEST NO. 545

WRIGHT FIELD FEBRUARY 1946

Condition No.	Lift (Lb)	Thrust (Lb)	Resultant (Lb)	Moment (Lb Ft)	H.P.	Lift / H.P.	Thrust / H.P.	Resultant / H.P.	H.P. / Dia.^{2}	RPM	Moment / H.P.
1	1.5	2.7	3.1	-1.9	.12	12.6	22.4	26.00	.013	682	-15.8
	2.4	5.9	6.4	-3.0	.42	5.7	14.1	15.2	.044	1002	-7.1
	4.0	11.5	12.2	-5.7	1.15	3.5	10.0	10.6	.122	1397	-5.0
	6.1	16.0	17.1	-9.2	2.06	3.0	7.8	8.3	.218	1710	-4.5
	8.4	23.8	25.2	-13.1	3.83	2.2	6.2	6.6	.405	2070	-3.4
	10.6	30.7	32.5	----	5.35	2.0	5.7	6.1	.565	2310	----
	13.5	38.7	41.0	----	7.44	1.8	5.2	5.5	.787	2580	----
	17.0	45.3	48.5	----	9.61	1.8	4.7	5.1	1.015	2800	----
2		0			.24					1192	
		0			.37					1704	
		0			.52					2270	
		0			.56					2533	
		0			.63					2770	
		0			.67					2912	
3	2.3	4.6	5.2	-3.4	.09	25.6	51.1	57.8	.010	653	-37.8
	4.0	8.9	9.8	-6.8	.41	9.8	21.7	23.9	.043	955	-16.6
	7.8	15.5	17.4	-14.5	1.09	7.2	14.2	16.0	.115	1325	-13.3
	11.7	22.6	25.4	-22.3	2.01	5.8	11.2	12.6	.212	1630	-11.1
	18.1	34.6	39.1	-35.5	3.86	4.7	9.0	10.1	.407	1968	-9.2
	24.1	45.7	51.6	-46.5	5.71	4.2	8.0	9.0	.602	2246	-8.1
	33.7	55.9	65.2	-64.5	7.73	4.3	7.2	8.4	.816	2500	-8.3
4		10.1			.22					1171	
		10.1			.38					1689	
		24.2			.33					1744	
		25.4			.46					2267	
		46.0			.43					2280	
		46.0			.49					2560	

TABLE NO. 2

CUSTER CHANNEL WING

FIVE-FOOT WIND TUNNEL TEST NO. 545

WRIGHT FIELD FEBRUARY 1946

Condition No.	Lift (Lb)	Thrust (Lb)	Resultant (Lb)	Moment (Lb Ft)	H.P.	Lift / H.P.	Thrust / H.P.	Resultant / H.P.	H.P. / Dia.^{2}	RPM	Moment / H.P.
5	2.2	4.2	4.7	——	.12	18.3	35.0	39.0	.013	715	——
	4.2	8.4	9.4	——	.39	10.8	21.5	24.1	.041	1000	——
	8.3	16.1	18.1	——	1.18	7.0	13.6	15.3	.124	1400	——
	12.0	24.5	27.3	——	2.18	5.0	11.3	12.5	.230	1678	——
	17.7	35.0	39.3	——	4.17	4.2	8.4	9.5	.440	2050	——
	24.0	45.5	51.5	——	5.94	4.1	7.7	8.7	.628	2315	——
	27.5	58.0	64.3	——	7.91	3.5	7.3	8.2	.835	2570	——
6	23.2	35.0	42.0	——	3.96	5.8	8.9	10.6	.418	2020	——
	24.2	45.6	51.5	——	5.74	4.2	8.0	9.0	.605	2310	——
	29.2	55.7	62.7	——	8.03	3.7	7.0	7.8	.848	2580	——
7 A	34.2	56.5	66.0	——	8.51	4.0	6.7	7.8	.898	2570	——
B	40.6	54.5	68.0	——	8.62	4.7	6.4	7.9	.908	2600	——
C	43.7	52.6	68.2	——	8.62	5.1	6.1	8.0	.908	2630	——
D	34.5	58.6	68.0	——	9.02	3.8	6.5	7.6	.950	2610	——
E	39.5	62.0	73.5	——	10.38	3.8	6.0	7.1	1.095	2780	——
F	39.1	49.7	63.3	——	8.82	4.4	5.6	7.2	.932	2615	——
G	39.0	50.1	63.5	——	8.04	4.9	6.2	7.9	.848	2550	——
H	39.8	52.5	65.7	——	8.33	4.8	6.3	7.9	.880	2570	——
I	34.0	55.7	65.0	——	8.52	4.0	6.6	7.6	.899	2591	——
J	35.2	52.7	63.3	——	8.52	4.1	6.2	7.4	.899	2610	——
C	38.1	52.9	65.2	——	8.72	4.4	6.1	7.5	.920	2612	——
D	33.1	56.2	65.2	——	8.92	3.7	6.3	7.3	.940	2630	——
K	39.1	49.7	63.3	——	8.72	4.5	5.7	7.3	.920	2640	——
L	35.8	50.3	61.7	——	8.52	4.2	5.9	7.3	.899	2640	——
L	35.5	51.7	62.7	——	8.47	4.2	6.1	7.4	.893	2630	——

TABLE NO. 3
CUSTER CHANNEL WING
FIVE-FOOT WIND TUNNEL TEST NO. 545
WRIGHT FIELD FEBRUARY 1946

Condition No.	Lift (Lb)	Thrust (Lb)	Resultant (Lb)	Moment (Lb Ft)	H.P.	Lift / H.P.	Thrust / H.P.	Resultant / H.P.	H.P. / Dia.^{2}	RPM	Moment / H.P.
8 A	29.7	53.2	60.8	-57.6	8.24	3.6	6.5	7.4	.870	2547	-7.0
B	27.9	56.4	63.0	-52.1	8.34	3.4	6.8	7.6	.880	2560	-6.3
C	31.4	54.4	62.8	-63.3	8.44	3.7	6.5	7.5	.890	2570	-7.5
D	32.4	54.0	63.0	-68.9	8.53	3.8	6.3	7.4	.900	2590	-8.1
E	34.9	50.2	61.0	-79.1	8.43	4.1	5.9	7.2	.890	2580	-9.4
F	36.2	50.6	62.2	-84.6	8.43	4.3	6.0	7.4	.890	2580	-10.0
G	40.1	51.4	65.2	-97.8	8.53	4.7	6.0	7.6	.900	2580	-11.5
H	39.7	47.9	62.2	-101.2	8.54	4.7	5.6	7.3	.900	2570	-11.8
I	41.5	47.6	63.0	-102.1	8.64	4.8	5.5	7.3	.910	2570	-11.8
J	38.7	48.2	61.7	-100.2	8.63	4.5	5.6	7.1	.910	2589	-11.6
K	39.4	47.4	61.5	-97.8	8.63	4.6	5.5	7.1	.910	2590	-11.3
L	39.6	49.9	63.5	-97.8	8.54	4.6	5.8	7.4	.900	2590	-11.4
M	38.9	49.2	62.8	-97.9	8.54	4.6	5.8	7.4	.900	2590	-11.4
N	39.4	50.0	63.5	-99.3	8.63	4.6	5.8	7.4	.910	2590	-11.5
9	3.6	3.3	4.9	-8.2	.09	40.0	36.8	54.5	.010	726	-91.0
	6.3	7.2	9.5	-14.8	.38	16.6	19.0	25.0	.043	1006	-38.9
	11.7	13.6	17.9	-28.2	1.11	10.5	12.3	16.1	.117	1378	-25.2
	16.4	19.4	25.4	-40.3	2.07	9.9	11.7	15.3	.218	1660	-19.5
	24.9	30.2	39.2	-61.5	4.04	6.2	7.5	9.7	.427	2035	-15.2
	32.6	38.3	50.4	-80.3	5.98	5.5	6.4	8.4	.630	2310	-13.4
	39.9	49.1	63.3	-99.3	8.37	4.8	5.9	7.6	.882	2590	-11.8
10	38.5	48.5	61.8	-98.9	8.59	4.5	5.7	7.2	.905	2610	-11.5
	39.1	50.1	63.6	-98.9	8.47	4.6	5.9	7.5	.895	2590	-11.7
11	3.2	2.3	3.9	-6.7	.11	29.1	20.9	35.5	.012	691	-61.0
	6.2	5.7	8.4	-13.2	.43	14.4	13.3	19.6	.045	992	-30.7
	11.4	12.1	16.6	-26.5	1.16	9.8	10.4	14.3	.123	1356	-22.8
	17.1	16.7	23.9	-39.9	2.07	8.3	8.1	11.6	.219	1640	-19.3
	27.0	26.7	38.0	-59.9	3.90	6.9	6.9	9.8	.412	2010	-15.3
	33.4	35.3	47.5	-80.0	5.62	5.9	6.3	8.5	.592	2270	-14.2
	39.6	51.3	65.0	-97.5	7.74	5.1	6.6	8.4	.818	2520	-12.6

TABLE NO. 4
CUSTER CHANNEL WING
FIVE-FOOT WIND TUNNEL TEST NO. 545
WRIGHT FIELD MARCH 1946

Condition No.	Lift (Lb)	Thrust (Lb)	Resultant (Lb)	Moment (Lb Ft)	H.P.	Lift / H.P.	Thrust / H.P.	Resultant / H.P.	H.P. / Dia.^{2}	RPM	Moment / H.P.
12	3.8	2.6	4.6	-8.9	.12	31.6	21.7	38.3	.012	720	-74.0
	6.7	5.7	8.3	-16.7	.40	15.2	14.3	20.8	.042	998	-41.8
	12.5	11.0	16.7	-32.1	1.12	11.2	9.8	14.9	.118	1365	-28.7
	18.2	15.7	24.2	-47.7	2.08	8.8	7.6	11.6	.219	1665	-22.9
	27.1	24.0	36.0	-70.0	3.92	6.9	6.1	9.2	.413	2020	-17.8
	36.5	31.0	49.8	-94.6	5.65	6.5	5.5	8.8	.596	2270	-16.8
	42.1	40.0	58.5	-114.4	7.79	5.4	5.1	7.5	.822	2520	-14.7
13	9.1	14.7	17.3	-16.1	1.16	7.8	12.7	14.9	.156	1505	-13.9
	13.0	21.4	25.0	-25.3	2.00	6.5	10.7	12.5	.251	1802	-12.7
	21.7	38.7	44.3	-42.9	5.30	4.1	7.3	8.4	.616	2430	-8.1
	26.7	47.8	54.8	-53.9	7.02	3.8	6.8	7.8	.805	2685	-7.7
14	2.2	4.4	4.9	-4.4	.14	15.7	31.4	35.0	.015	682	-31.4
	5.8	8.1	9.9	-9.8	.44	13.2	18.4	22.5	.047	946	-22.2
	8.6	14.7	17.0	-15.4	1.23	7.0	12.0	13.8	.130	1320	-12.5
	12.6	22.3	25.7	-24.2	2.23	5.6	10.0	11.5	.235	1592	-10.8
	17.9	34.0	38.4	-35.3	4.33	4.1	7.9	8.9	.457	1960	-8.2
	24.1	44.0	50.2	-48.6	6.40	3.8	6.9	7.8	.675	2235	-7.6
15	1.7	2.3	2.9	-3.2	.11	15.4	20.9	26.4	.012	832	-29.1
	4.6	5.9	7.5	-7.6	.37	12.4	21.0	20.2	.039	1220	-20.5
	7.2	12.1	14.0	-13.2	.96	7.5	12.6	14.6	.101	1681	-13.8
	9.3	16.9	19.3	-17.6	1.59	5.8	10.6	12.1	.167	2011	-11.1
	12.3	23.2	26.2	-24.2	2.56	4.8	9.1	10.2	.270	2360	-9.4
	15.1	28.5	32.3	-30.9	3.40	4.4	8.4	9.5	.359	2584	-9.1
16	1.6	3.4	3.8	-3.2	.14	11.4	24.2	27.2	.015	687	-22.9
	3.8	7.6	8.5	-7.7	.46	8.3	16.5	18.5	.049	991	-16.7
	8.7	14.9	17.3	-16.5	1.21	7.2	12.3	14.3	.127	1356	-13.6
	12.7	21.8	25.2	-25.3	2.18	5.8	10.0	11.6	.230	1643	-11.6
	17.2	32.3	36.6	-34.2	4.10	4.2	7.9	8.9	.432	2014	-8.3
	23.4	43.8	49.8	-47.4	5.94	3.9	7.4	8.4	.626	2290	-8.0
	28.2	52.6	59.5	-57.3	8.18	3.5	6.4	7.3	.862	2550	-7.0

TABLE NO. 5
CUSTER CHANNEL WING
FIVE-FOOT WIND TUNNEL TEST NO. 545
WRIGHT FIELD APRIL 1946

Condition No.	Lift (Lb)	Thrust (Lb)	Resultant (Lb)	Moment (Lb Ft)	H.P.	Lift / H.P.	Thrust / H.P.	Resultant / H.P.	H.P. / Dia.^{2}	RPM	Moment / H.P.
17	8.3	14.9	17.0	-16.5	1.21	6.9	12.3	14.1	.128	1305	-13.6
	11.2	22.9	25.4	-22.0	2.23	5.0	10.3	11.4	.235	1613	-9.9
	18.6	35.0	39.8	-36.4	4.21	4.4	8.4	9.5	.444	1990	-8.6
	24.2	45.4	51.4	-47.4	6.12	4.0	7.4	8.4	.645	2263	-7.7
	28.4	57.2	63.8	-55.1	8.56	3.3	6.7	7.5	.900	2535	-6.4
18	1.6	2.8	3.2	-3.3	.12	13.3	23.4	26.6	.013	618	-27.5
	3.4	6.5	7.3	-6.6	.43	7.9	15.1	17.0	.046	913	-15.3
	7.3	13.9	15.7	-14.3	1.17	6.2	11.9	13.4	.124	1282	-12.2
	10.4	21.6	23.9	-19.8	2.18	4.8	10.0	11.0	.230	1590	-9.1
	16.0	32.4	36.0	-30.9	4.20	3.8	7.7	8.6	.444	1955	-7.4
	20.5	43.4	48.0	-39.6	6.24	3.2	7.0	7.7	.660	2235	-6.3
	26.3	54.3	60.4	-51.8	9.28	2.8	5.9	6.5	.980	2535	-5.6
19	——	——	——	——	.27	——	——	——	——	1181	——
	——	——	——	——	.46	——	——	——	——	1747	——
	——	——	——	——	.61	——	——	——	——	2320	——
	——	——	——	——	.69	——	——	——	——	2611	——
20	1.1	2.3	2.5	-2.1	.09	12.2	25.6	27.8	.010	607	-23.4
	3.2	6.1	6.9	-6.4	.36	8.9	17.0	19.2	.038	962	-17.8
	6.3	13.7	15.1	-13.3	1.01	6.2	13.6	15.0	.107	1362	-13.1
	10.5	20.1	22.7	-22.1	1.86	5.6	10.8	12.2	.197	1700	-11.9
	15.8	29.8	33.8	-33.1	3.35	4.7	8.9	10.1	.354	2071	-9.9
	20.7	38.1	43.3	-43.0	4.99	4.2	7.6	8.7	.528	2335	-8.6
	24.4	47.1	53.0	-50.8	6.69	3.7	7.1	7.9	.707	2584	-7.6
21	2.0	2.3	3.0	-5.5	.10	20.0	23.0	30.5	.015	662	-55.0
	5.0	5.4	7.3	-14.5	.39	12.8	13.9	18.9	.041	1000	-37.2
	10.2	10.8	14.8	-29.0	.91	11.3	11.9	16.4	.096	1413	-31.9
	16.6	15.7	22.8	-45.6	1.98	8.4	7.9	11.6	.209	1734	-23.0
	22.9	24.1	33.3	-65.8	3.79	6.0	6.4	8.7	.400	2120	-17.4
	29.9	30.2	42.5	-84.6	5.27	5.7	5.7	8.1	.556	2377	-16.0
	36.4	37.3	52.1	-103.5	7.21	5.1	5.2	7.3	.761	2640	-14.3

TABLE NO. 6
CUSTER CHANNEL WING
FIVE-FOOT WIND TUNNEL TEST NO. 545
WRIGHT FIELD MAY 1946

Condition No.	Lift (Lb)	Thrust (Lb)	Resultant (Lb)	Moment (Lb Ft)	H.P.	Lift / H.P.	Thrust / H.P.	Resultant / H.P.	H.P. / Dia.^{2}	RPM	Moment / H.P.
22	35.2	41.4	54.4	-95.5	7.53	4.7	5.5	7.2	.795	2650	-13.0
23	44.0	44.7	62.5	-124.6	8.98	4.9	5.0	7.0	.950	2588	-13.9
24	2.1	2.1	3.0	-6.7	.08	26.3	26.3	37.2	.008	605	-83.6
	5.9	4.8	7.5	-17.8	.34	17.4	14.1	22.4	.036	902	-52.3
	12.7	9.6	15.9	-37.9	1.04	12.2	9.2	15.3	.120	1272	-36.5
	19.7	16.2	25.5	-59.1	2.05	9.6	7.9	12.4	.216	1605	-28.8
	29.0	23.1	37.2	-88.0	3.98	7.3	5.8	9.3	.420	1977	-22.1
	35.3	31.9	47.5	-111.6	5.79	6.1	5.5	8.2	.611	2261	-19.3
	46.0	39.8	60.8	-142.7	8.34	5.5	4.8	7.3	.880	2530	-17.1
25	28.9	45.58	54.0	-55.0	8.20	3.5	5.6	6.6	.865	2497	-6.8
26	7.8	16.4	18.2	-15.4	1.12	7.0	14.7	16.3	.118	1299	-13.7
	11.9	25.9	28.5	-24.2	2.07	5.8	12.5	13.8	.218	1601	-11.7
	18.1	38.8	42.8	-36.4	4.04	4.5	9.6	10.6	.427	1962	-9.0
	23.4	50.8	56.0	-47.4	5.84	4.0	8.7	9.6	.617	2230	-8.1
	29.6	65.1	71.6	-60.7	8.33	3.6	7.8	8.6	.880	2501	-7.3
27	7.8	16.1	17.9	-15.4	1.11	7.0	14.5	16.1	.117	1272	-13.9
	12.3	25.7	28.5	-24.4	2.03	6.1	12.6	14.0	.214	1573	-12.0
	18.1	32.3	37.0	-35.3	3.96	4.6	9.7	10.7	.417	1946	-8.9
	23.1	49.3	54.5	-45.1	5.63	4.1	8.8	9.6	.594	2211	-8.0
	29.9	63.1	69.8	-58.4	8.00	3.7	7.9	8.7	.845	2469	-7.3
28	11.5	15.8	19.6	-31.1	1.09	10.6	14.5	18.0	.115	1308	-28.5
	16.9	23.2	28.7	-44.4	2.02	8.4	11.5	14.2	.213	1592	-22.0
	21.8	35.5	41.5	-57.8	3.90	5.6	9.1	10.7	.411	1960	-14.8
	30.6	47.1	56.0	-80.0	5.71	5.4	8.3	9.8	.602	2229	-14.0
	39.9	57.2	69.6	-104.3	8.03	5.0	7.1	8.7	.841	2488	-13.0

TABLE NO. 7
CUSTER CHANNEL WING
FIVE-FOOT WIND TUNNEL TEST NO. 545
WRIGHT FIELD MAY 1946

Condition No.	Lift (Lb)	Thrust (Lb)	Resultant (Lb)	Moment (Lb Ft)	H.P.	Lift / H.P.	Thrust / H.P.	Resultant / H.P.	H.P. / Dia.^{2}	RPM	Moment / H.P.
29	24.2	36.9	44.0	-61.1	4.11	5.9	9.0	10.8	.433	1988	-14.8
	30.8	48.1	57.1	-77.7	6.07	5.1	8.0	9.4	.640	2264	-12.8
	39.7	59.9	72.0	-99.8	8.56	4.7	7.0	8.4	.902	2548	-11.6
30	25.7	33.2	41.9	-70.0	4.02	6.4	8.3	10.5	.423	1946	-17.4
	33.6	44.2	55.5	-91.1	5.95	5.7	7.4	9.3	.628	2234	-15.3
	44.0	55.5	70.8	-117.8	8.28	5.3	6.7	8.6	.874	2500	-14.2
31	27.3	33.0	42.8	-76.7	4.40	6.2	7.5	9.7	.464	1981	-17.4
	34.9	42.7	54.0	-99.0	6.03	5.8	7.1	9.0	.636	2259	-16.4
	45.0	53.9	70.3	-125.6	8.54	5.3	6.3	8.2	.900	2534	-14.7
32	30.1	30.3	42.8	-86.8	4.18	7.2	7.3	10.2	.441	1991	-20.7
	38.2	40.7	55.8	-113.7	6.18	6.2	6.6	9.0	.652	2270	-18.4
	51.2	50.9	72.2	-148.1	8.76	5.8	5.8	8.2	.926	2550	-16.9
33	12.0	14.7	19.0	-30.0	1.14	10.5	12.9	16.7	.120	1303	-26.3
	17.6	23.1	29.0	-44.4	2.13	8.3	10.9	13.6	.225	1624	-20.7
	26.7	35.2	44.2	-67.7	4.27	6.3	8.3	10.4	.451	1996	-15.9
	34.1	46.6	57.8	-86.5	6.23	5.5	7.5	9.3	.657	2279	-13.9
	43.0	58.2	72.3	-109.9	8.93	4.8	6.5	8.1	.942	2568	-12.3
34	27.8	33.5	43.6	-73.4	4.27	6.5	7.9	10.2	.451	1997	-17.2
	35.0	44.2	56.3	-94.5	6.27	5.6	7.1	9.0	.662	2278	-15.1
	46.1	56.4	73.0	-122.2	8.99	5.1	6.3	8.2	.949	2562	-13.6
35 ✓	7.7	16.9	18.5	-15.4	1.09	7.1	15.5	17.0	.115	1456	-14.1
	11.6	24.6	27.2	-24.3	2.02	5.8	12.2	13.5	.213	1770	-12.0
	16.3	36.6	40.0	-34.1	3.79	4.3	9.7	10.6	.400	2151	-9.0
	22.1	46.6	51.5	-46.3	5.39	4.1	8.6	9.6	.568	2408	-8.6
	27.3	57.3	63.5	-57.3	7.25	3.8	7.9	8.8	.764	2664	-7.9

TABLE NO. 8

CUSTER CHANNEL WING

FIVE-FOOT WIND TUNNEL TEST NO. 545

WRIGHT FIELD MAY 1946

Condition No.	Lift (Lb)	Thrust (Lb)	Resultant (Lb)	Moment (Lb Ft)	H.P.	Lift / H.P.	Thrust / H.P.	Resultant / H.P.	H.P. / Dia.^{2}	RPM	Moment / H.P.
36	2.5	3.7	4.5	-4.4	.08	31.2	46.2	56.2	.008	710	-55.0
	4.5	8.0	9.2	-8.8	.35	12.9	22.9	26.3	.037	1030	-25.2
	7.9	15.6	17.5	-17.4	1.05	7.5	14.9	16.7	.110	1433	-16.5
	11.6	22.7	25.5	-23.1	1.89	6.1	12.0	13.5	.199	1737	-12.2
	16.3	33.5	37.3	-33.1	3.57	4.6	9.4	10.5	.376	2093	-9.3
	20.6	42.4	47.2	-41.9	5.02	4.1	8.4	9.4	.529	2350	-8.3
	25.2	51.4	57.2	-50.6	6.84	3.7	7.5	8.4	.720	2602	-7.4
37 ✓	16.7	33.7	37.6	-35.3	3.58	4.7	9.4	10.5	.378	2090	-9.9
	22.0	42.4	47.8	-44.1	4.91	4.5	8.6	8.7	.518	2344	-9.0
	28.0	50.9	58.0	-55.0	6.56	4.3	7.8	8.8	.692	2595	-8.4
38	8.0	16.4	18.3	-16.6	1.09	7.3	15.1	16.8	.115	1446	-15.2
	12.2	24.0	26.9	-24.2	1.97	6.2	12.2	13.7	.208	1766	-12.3
	18.0	34.5	39.0	-36.4	3.42	5.3	10.1	11.4	.361	2141	-10.6
✓	22.7	43.8	49.5	-46.3	5.27	4.3	8.3	9.4	.557	2404	-8.8
	29.0	54.4	61.6	-58.4	6.91	4.2	7.9	8.9	.730	2667	-8.4
39	8.0	16.3	18.2	-16.6	1.11	7.2	14.7	16.4	.117	1322	-15.0
	12.2	24.9	27.7	-25.4	2.05	6.0	12.1	13.5	.216	1621	-12.4
✓	18.7	36.8	41.3	-38.6	3.96	4.7	9.3	10.4	.417	1994	- 9.7
	23.9	47.7	53.4	-49.6	5.76	4.2	8.3	9.3	.608	2247	-8.6
	29.6	60.0	66.8	-62.9	8.10	3.7	7.4	8.3	.854	2516	-7.8

TABLE NO. 9

CUSTER CHANNEL WING

FIVE-FOOT WIND TUNNEL TEST NO. 545

WRIGHT FIELD MAY 1946

Condition No.	Thrust (Lb)	H.P.	$\frac{\text{Thrust}}{\text{H.P.}}$	$\frac{\text{H.P.}}{\text{Dia.}^2}$	RPM
40	17.9	1.14	15.7	.120	1328
	26.6	2.09	12.7	.220	1615
	40.3	4.01	10.1	.423	1973
	52.0	5.80	9.0	.612	2239
	65.6	8.05	8.2	.850	2507
41	16.1	1.13	14.2	.119	1067
	25.9	2.32	11.2	.245	1320
	41.9	4.57	9.2	.482	1646
	57.1	7.28	7.9	.768	1927
42	5.5	.36	15.3	.038	608
	10.9	1.09	10.0	.115	847
	17.2	2.24	7.7	.236	1052
	28.8	4.57	6.3	.482	1334
43	16.0	1.03	15.5	.108	1488
	24.2	1.84	13.2	.194	1820
	34.5	3.09	11.2	.326	2174
	43.6	4.52	9.6	.476	2421
44	18.2	1.09	16.7	.115	1333
	27.3	2.04	13.4	.215	1634
X	40.5	3.89	10.4	.411	1999
	53.3	5.74	9.3	.606	2254
	66.0	8.00	8.3	.844	2510
45	8.6	.32	26.9	.036	1052
	17.9	.97	18.5	.102	1482
X	25.5	1.75	14.6	.185	1797
	36.7	2.96	12.4	.314	2148
	46.3	4.40	10.5	.465	2394
	55.9	5.69	9.8	.602	2620

TABLE NO. 10

CUSTER CHANNEL WING

FIVE-FOOT WIND TUNNEL TEST NO. 545

WRIGHT FIELD MAY 1946

Condition No.	Thrust (Lb)	H.P.	Thrust / H.P.	H.P. / $Dia.^2$	RPM
46	4.2	.08	52.5	.008	753
	9.2	.35	26.2	.037	1106
	17.1	1.00	17.1	.106	1512
	23.9	1.74	13.8	.184	1829
	35.1	3.03	11.6	.320	2175
	44.1	4.47	9.9	.472	2417
47	9.0	.42	21.4	.044	816
	18.2	1.21	15.0	.128	1171
	28.0	2.29	12.2	.242	1432
	42.1	4.45	9.5	.469	1777
	54.6	6.82	8.1	.720	2052
48	9.5	.41	23.2	.043	937
	18.3	1.15	15.9	.121	1317
	26.9	2.10	12.8	.222	1616
	42.7	4.01	10.7	.423	1953
	51.1	5.82	8.8	.614	2217
49	9.5	.41	23.2	.043	947
	18.3	1.15	15.9	.121	1326
	27.0	2.08	13.0	.220	1607
	41.1	4.01	10.3	.423	1960
	52.7	5.82	9.1	.613	2218
	66.7	8.11	8.2	.856	2484
50	9.4	.37	25.4	.039	950
	18.5	1.09	17.0	.115	1313
	26.7	2.02	12.7	.224	1605

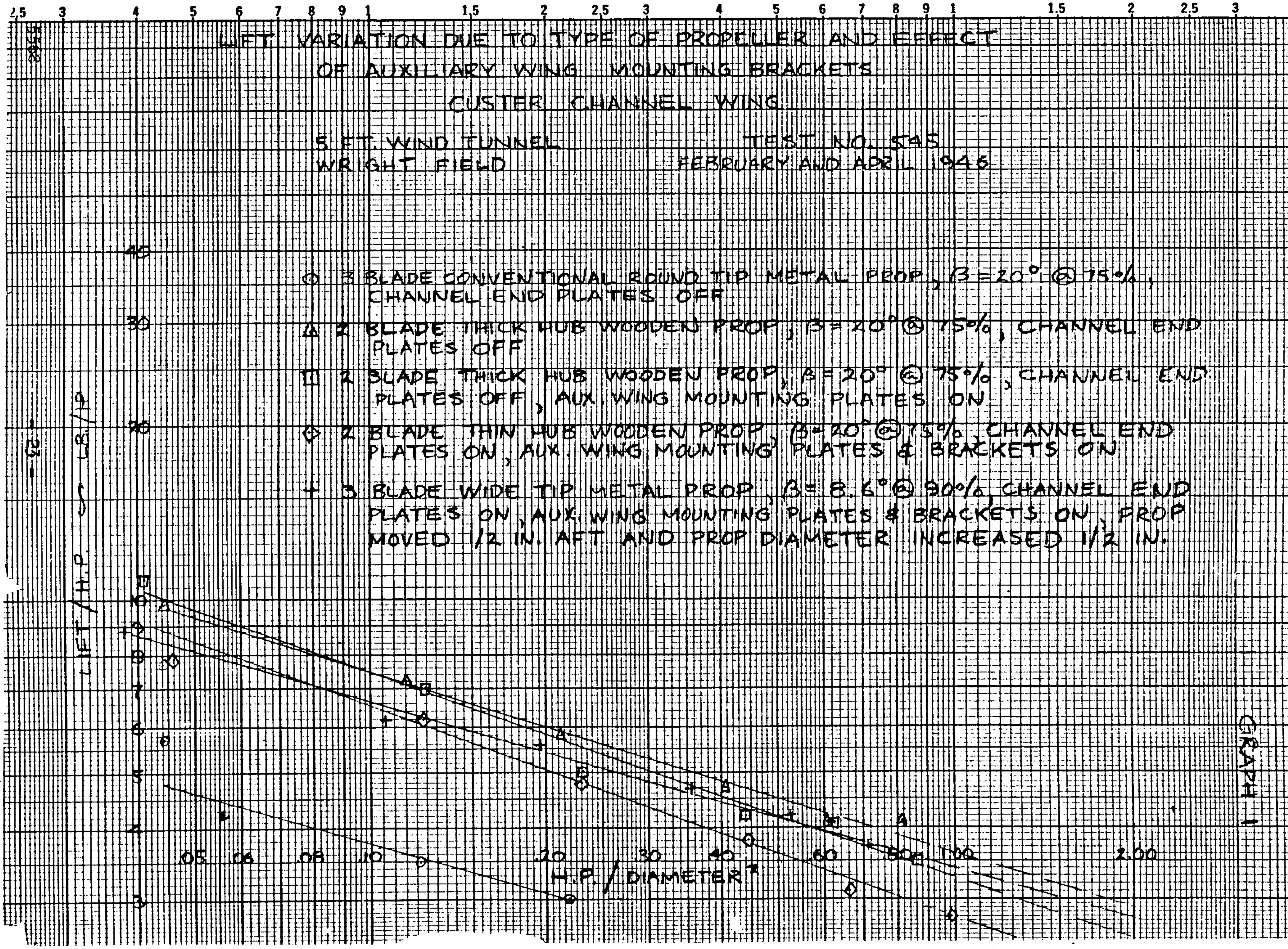
TABLE NO. 11

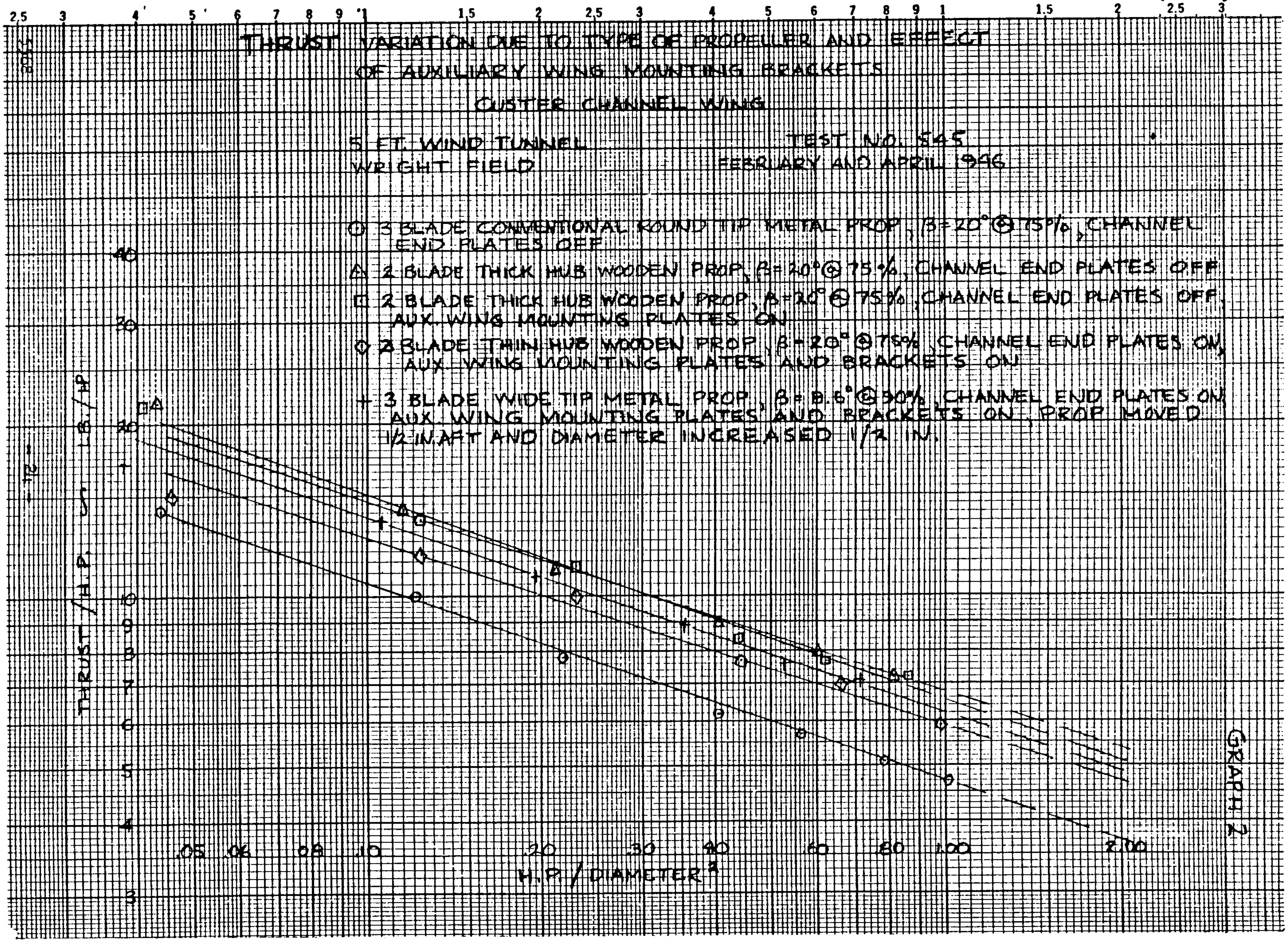
CUSTER CHANNEL WING

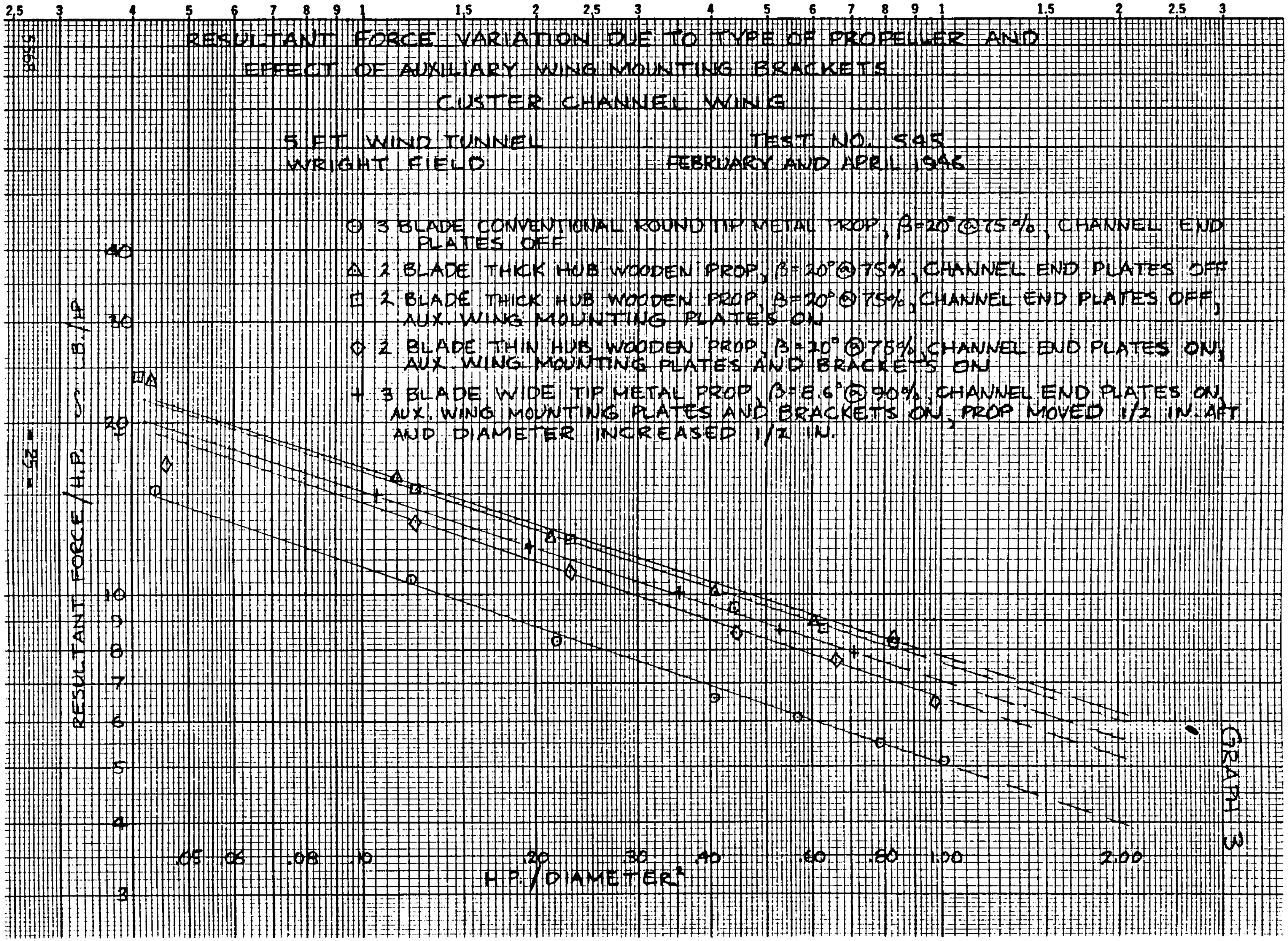
FIVE-FOOT WIND TUNNEL TEST NO. 545

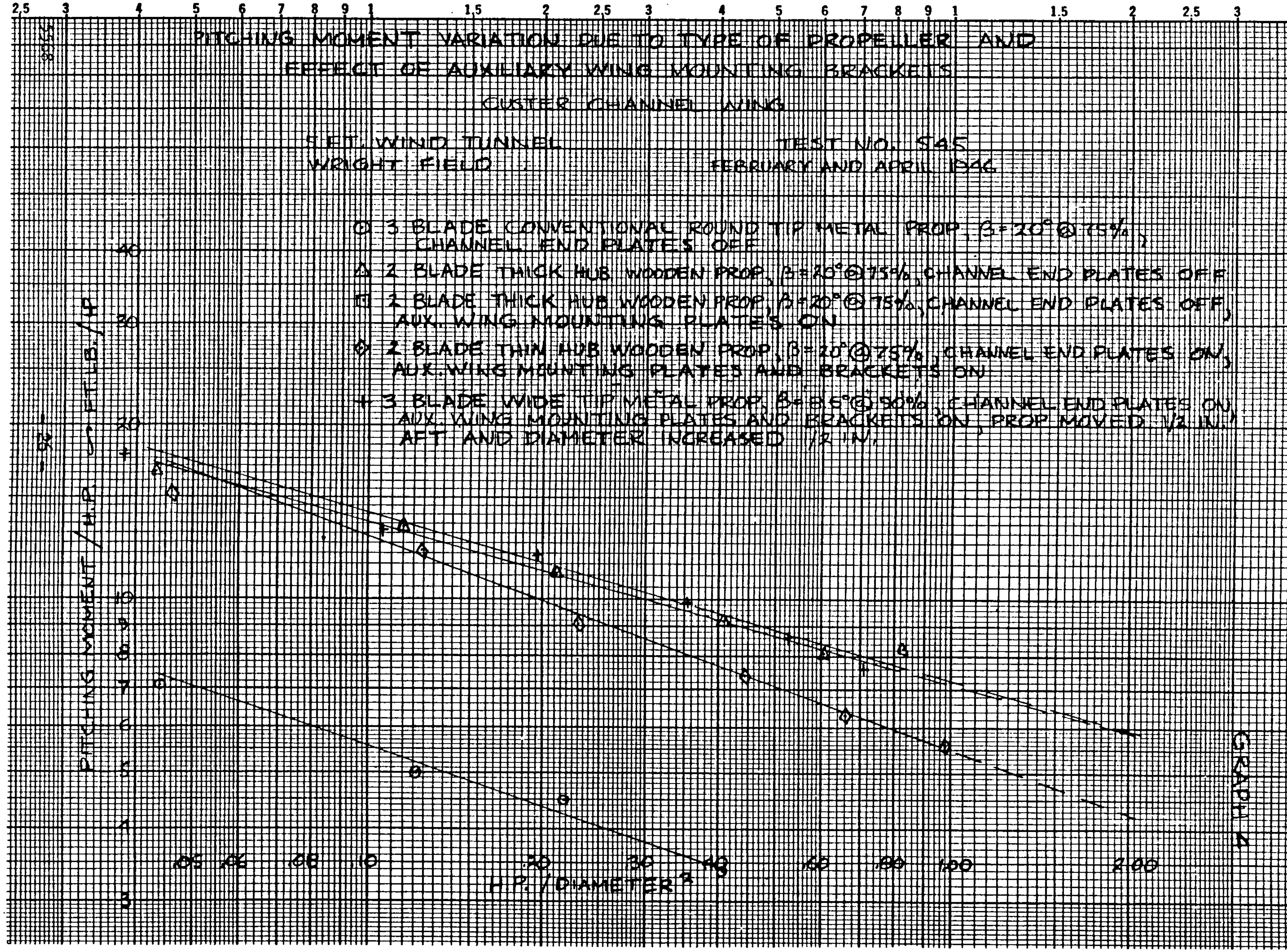
WRIGHT FIELD MAY 1946

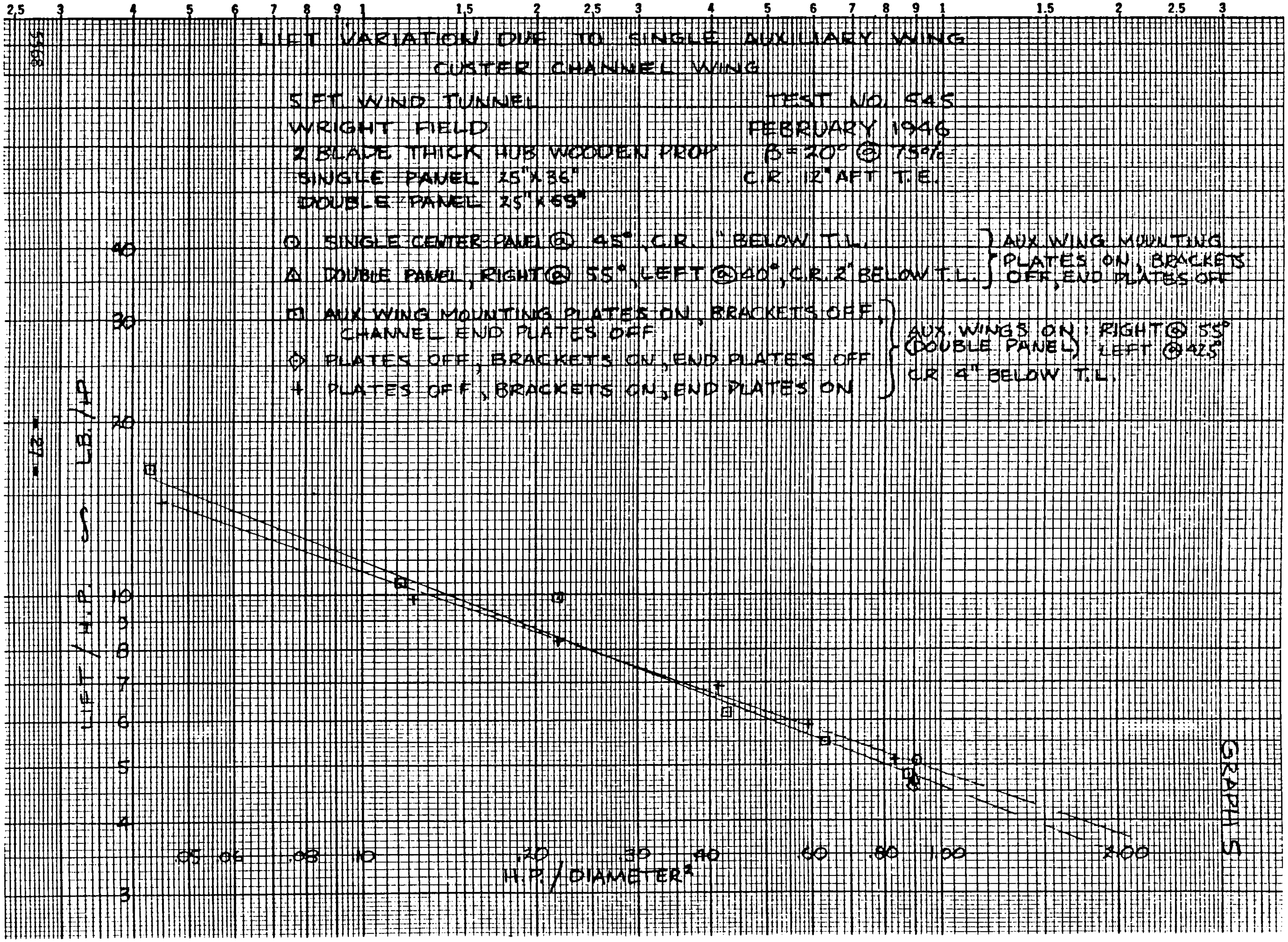
Condition No.	Thrust (Lb)	H.P.	Thrust / H.P.	H.P. / Dia.^{2}	RPM
51	9.2	.37	24.9	.039	939
	18.0	1.10	16.4	.116	1330
	26.6	2.01	13.2	.212	1611
	39.6	3.84	10.3	.411	1957
	50.8	5.57	9.1	.588	2214
	63.0	7.69	8.2	.811	2475
52	9.2	.37	24.8	.039	932
	18.4	1.10	16.7	.116	1311
	27.8	2.09	13.3	.220	1604
	42.1	4.14	10.2	.437	1985
	55.6	6.09	9.1	.642	2253
	70.4	8.74	8.1	.922	2547
53	3.7	.08	46.3	.008	739
	8.3	.36	23.0	.038	1075
	16.8	.99	17.0	.104	1481
X	24.0	1.76	13.6	.186	1789
	34.6	3.09	11.2	.326	2153
	44.2	4.55	9.7	.480	2391
	52.0	5.90	8.8 ✓	.622	2617


LIFT VARIATION DUE TO TYPE OF PROPELLER AND EFFECT
OF AUXILIARY WING MOUNTING BRACKETS
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY AND APRIL 1946
⊙ 3 BLADE CONVENTIONAL ROUND TIP METAL PROP, β = 20° @ 75%, CHANNEL END PLATES OFF
△ 2 BLADE THICK HUB WOODEN PROP, β = 20° @ 75%, CHANNEL END PLATES OFF
□ 2 BLADE THICK HUB WOODEN PROP, β = 20° @ 75%, CHANNEL END PLATES OFF, AUX. WING MOUNTING PLATES ON
◇ 2 BLADE THIN HUB WOODEN PROP, β = 20° @ 75%, CHANNEL END PLATES ON, AUX. WING MOUNTING PLATES & BRACKETS ON
+ 3 BLADE WIDE TIP METAL PROP, β = 8.6° @ 90%, CHANNEL END PLATES ON, AUX. WING MOUNTING PLATES & BRACKETS ON, PROP MOVED 1/2 IN. AFT AND PROP DIAMETER INCREASED 1/2 IN.
LIFT / H.P. ~ LB/HP
H.P. / DIAMETER²
GRAPH I

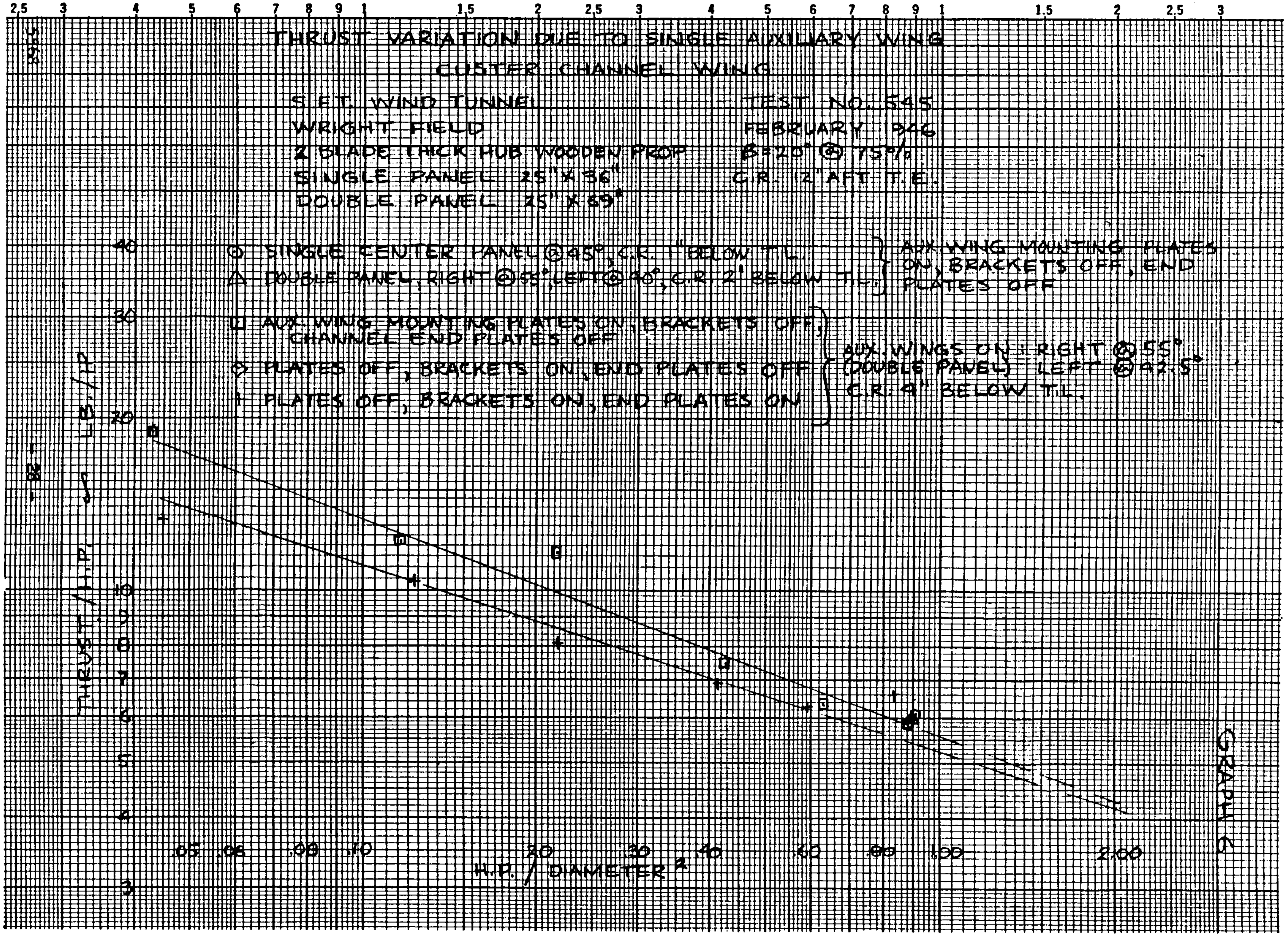

THRUST VARIATION DUE TO TYPE OF PROPELLER AND EFFECT
OF AUXILIARY WING MOUNTING BRACKETS
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY AND APRIL 1946
○ 3 BLADE CONVENTIONAL ROUND TIP METAL PROP, β=20° @ 75%, CHANNEL END PLATES OFF
△ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF
□ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF, AUX. WING MOUNTING PLATES ON
◇ 2 BLADE THIN HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES ON, AUX. WING MOUNTING PLATES AND BRACKETS ON
+ 3 BLADE WIDE TIP METAL PROP, β=8.6° @ 90%, CHANNEL END PLATES ON, AUX. WING MOUNTING PLATES AND BRACKETS ON, PROP MOVED 1/2 IN. AFT AND DIAMETER INCREASED 1/2 IN.
THRUST / H.P. ∫ LB./HP
H.P. / DIAMETER²
GRAPH 2


RESULTANT FORCE VARIATION DUE TO TYPE OF PROPELLER AND
EFFECT OF AUXILIARY WING MOUNTING BRACKETS
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY AND APRIL 1946
○ 3 BLADE CONVENTIONAL ROUND TIP METAL PROP, β=20° @ 75%, CHANNEL END PLATES OFF
△ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF
□ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF, AUX. WING MOUNTING PLATES ON
◇ 2 BLADE THIN HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES ON, AUX. WING MOUNTING PLATES AND BRACKETS ON
+ 3 BLADE WIDE TIP METAL PROP, β=8.6° @ 90%, CHANNEL END PLATES ON, AUX. WING MOUNTING PLATES AND BRACKETS ON, PROP MOVED 1/2 IN. AFT AND DIAMETER INCREASED 1/2 IN.
RESULTANT FORCE / H.P.
B./HP
H.P./DIAMETER²
GRAPH 3

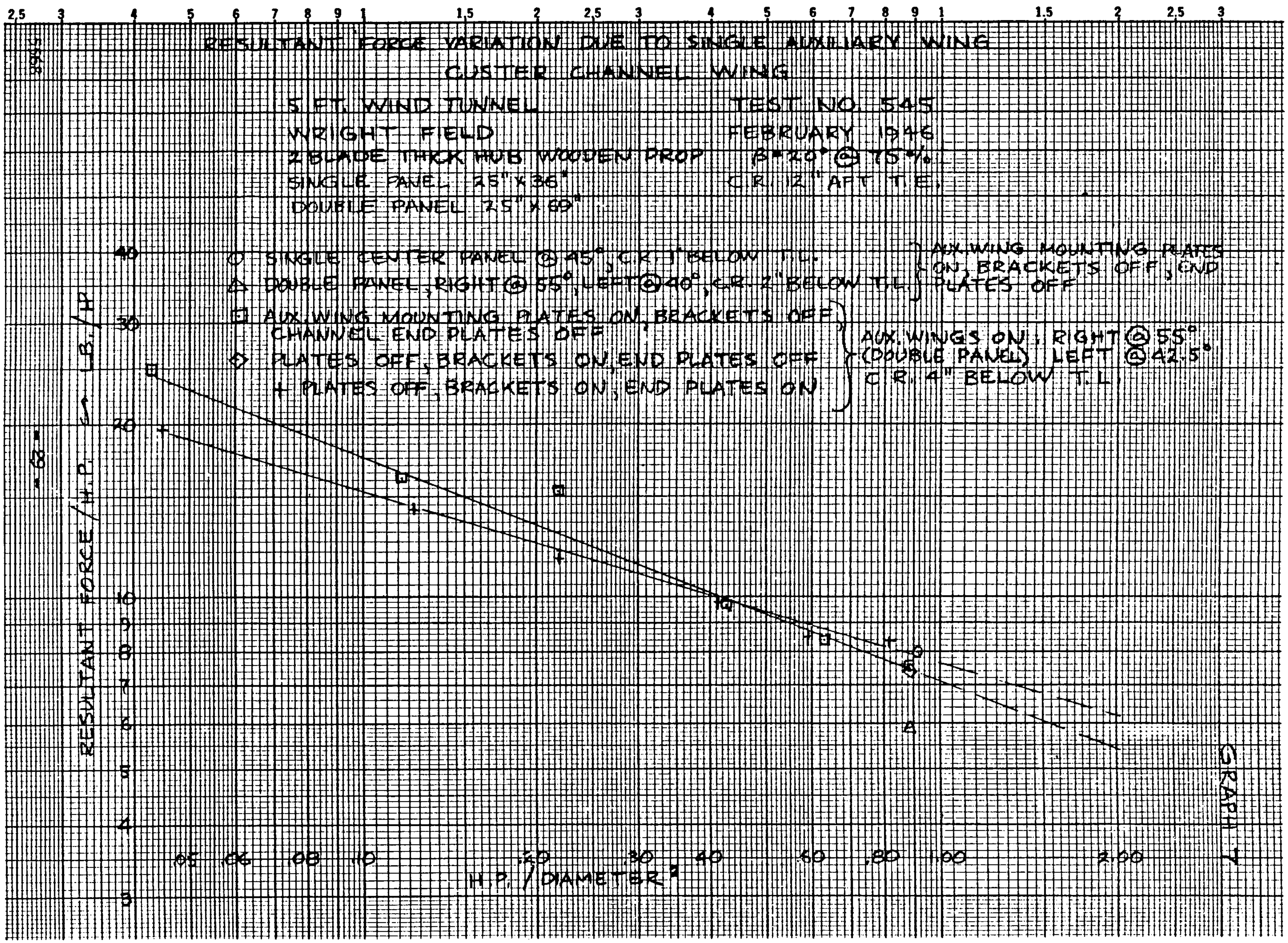

PITCHING MOMENT VARIATION DUE TO TYPE OF PROPELLER AND
EFFECT OF AUXILIARY WING MOUNTING BRACKETS
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
WRIGHT FIELD
TEST NO. 545
FEBRUARY AND APRIL 1946
⊙ 3 BLADE CONVENTIONAL ROUND TIP METAL PROP, β=20° @ 75%, CHANNEL END PLATES OFF
△ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF
⊡ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF, AUX. WING MOUNTING PLATES ON
◇ 2 BLADE THIN HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES ON, AUX. WING MOUNTING PLATES AND BRACKETS ON
+ 3 BLADE WIDE TIP METAL PROP, β=8.5° @ 90%, CHANNEL END PLATES ON, AUX. WING MOUNTING PLATES AND BRACKETS ON, PROP MOVED 1/2 IN. AFT AND DIAMETER INCREASED 1/2 IN.
PITCHING MOMENT / H.P. — FT. LB./HP
H.P. / DIAMETER²
GRAPH 4

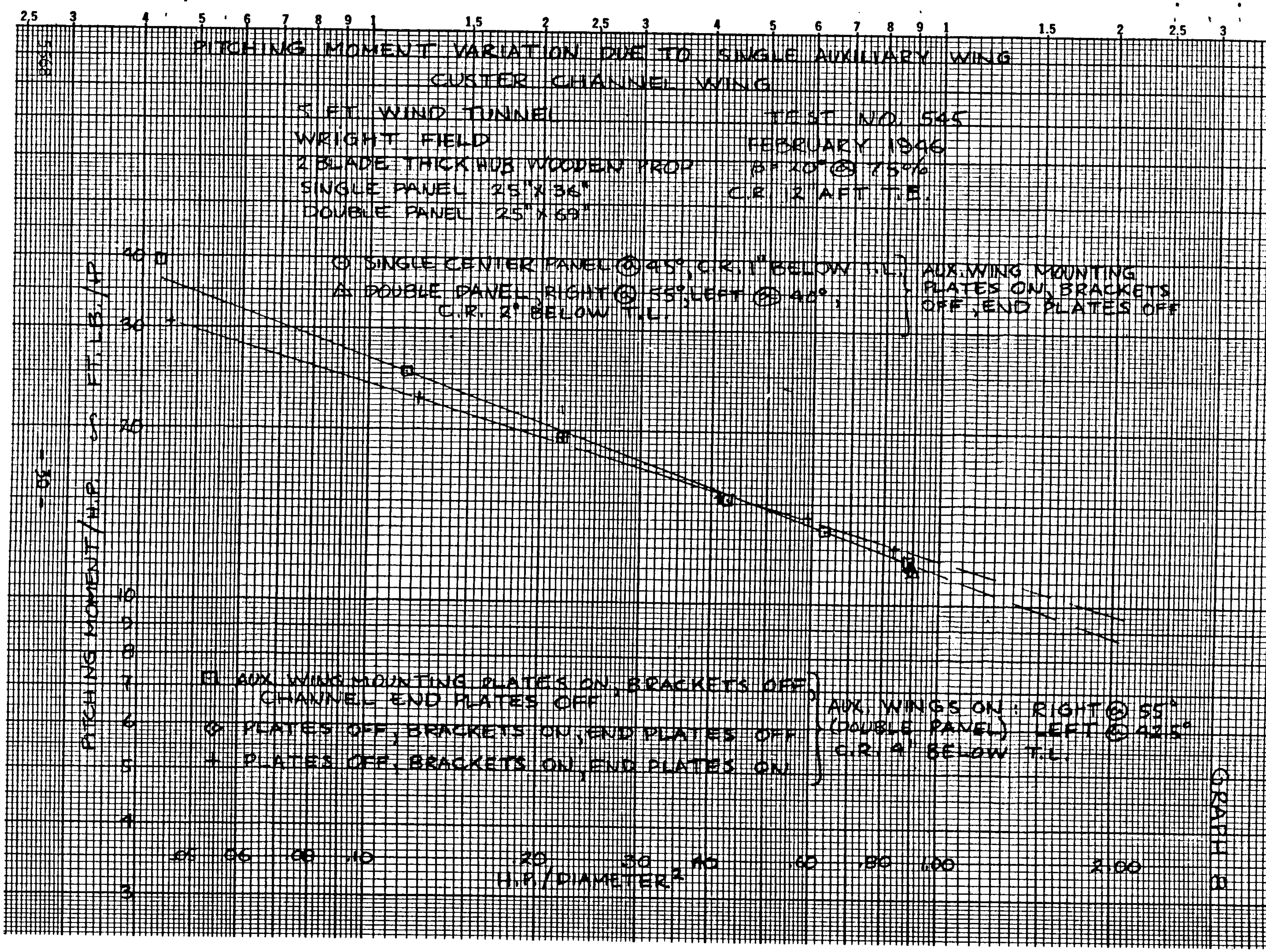


LIFT VARIATION DUE TO SINGLE AUXILIARY WING
CUSTER CHANNEL WING
5 FT WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY 1946
2 BLADE THICK HUB WOODEN PROP
β = 20° @ 75%
SINGLE PANEL 25" x 36"
C.R. 12" AFT T.E.
DOUBLE PANEL 25" x 69"
○ SINGLE CENTER PANEL @ 45°, C.R. " BELOW T.L.
△ DOUBLE PANEL, RIGHT @ 55°, LEFT @ 40°, C.R. 2" BELOW T.L.
AUX WING MOUNTING PLATES ON, BRACKETS OFF, END PLATES OFF
□ AUX WING MOUNTING PLATES ON, BRACKETS OFF, CHANNEL END PLATES OFF
◇ PLATES OFF, BRACKETS ON, END PLATES OFF
+ PLATES OFF, BRACKETS ON, END PLATES ON
AUX WINGS ON (DOUBLE PANEL) RIGHT @ 55° LEFT @ 42.5°
C.R. 4" BELOW T.L.
LIFT / H.P. ∫ LB./H.P.
H.P. / DIAMETER²
GRAPH 5

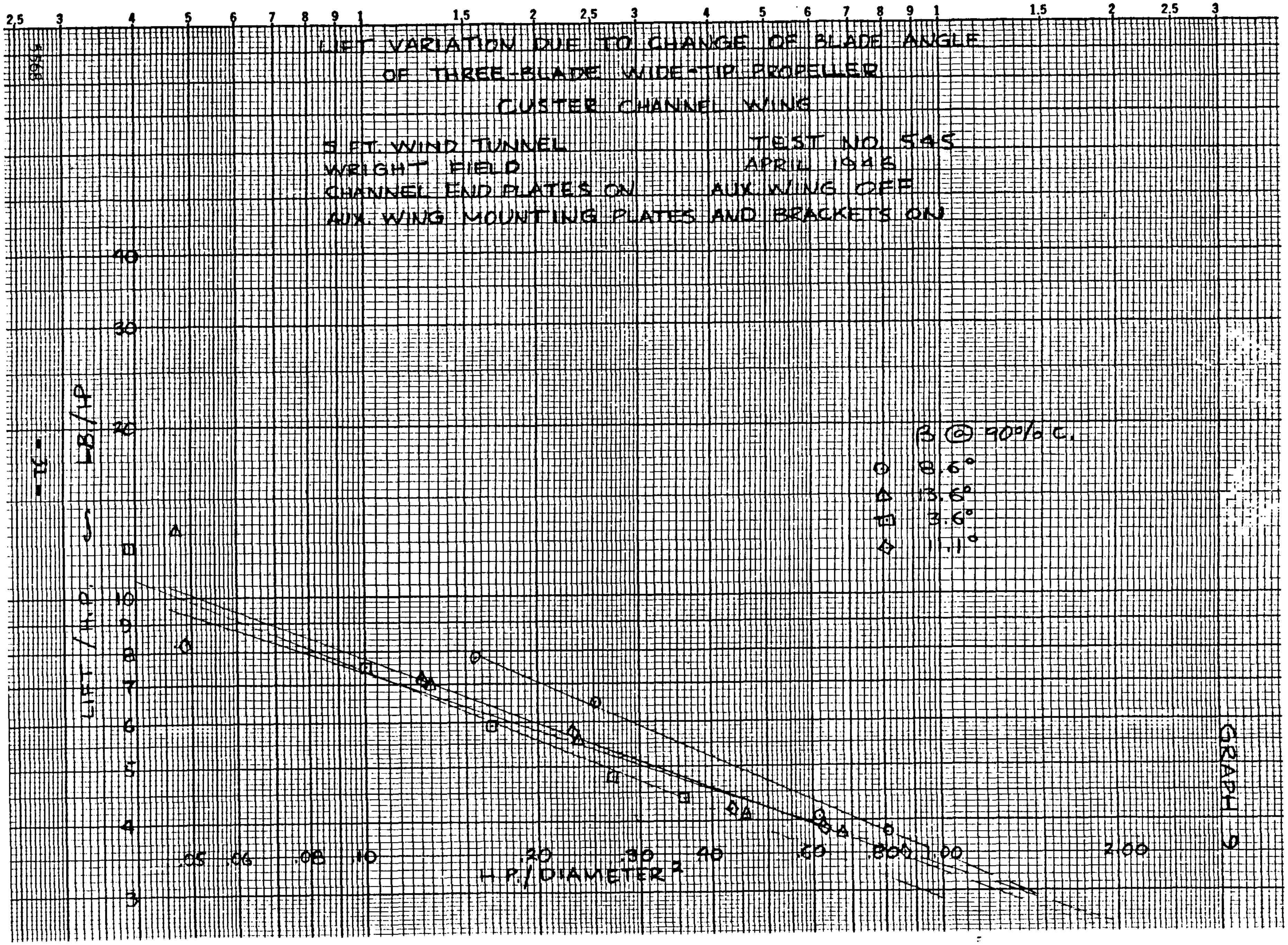


THRUST VARIATION DUE TO SINGLE AUXILIARY WING
COSTER CHANNEL WING
5 FT. WIND TUNNEL
WRIGHT FIELD
2 BLADE THICK HUB WOODEN PROP
SINGLE PANEL 25" X 36"
DOUBLE PANEL 25" X 69"
TEST NO. 545
FEBRUARY 1946
β=20° @ 75%
C.R. 12" AFT T.E.
⊙ SINGLE CENTER PANEL @ 45°, C.R. 1" BELOW T.L.
△ DOUBLE PANEL, RIGHT @ 55°, LEFT @ 40°, C.R. 2" BELOW T.L.
AUX WING MOUNTING PLATES ON, BRACKETS OFF, END PLATES OFF
□ AUX WING MOUNTING PLATES ON, BRACKETS OFF, CHANNEL END PLATES OFF
◇ PLATES OFF, BRACKETS ON, END PLATES OFF
+ PLATES OFF, BRACKETS ON, END PLATES ON
AUX. WINGS ON: RIGHT @ 55° (DOUBLE PANEL) LEFT @ 42.5° C.R. 4" BELOW T.L.
THRUST / H.P. ~ LB./H.P.
H.P. / DIAMETER ²
GRAPH 6

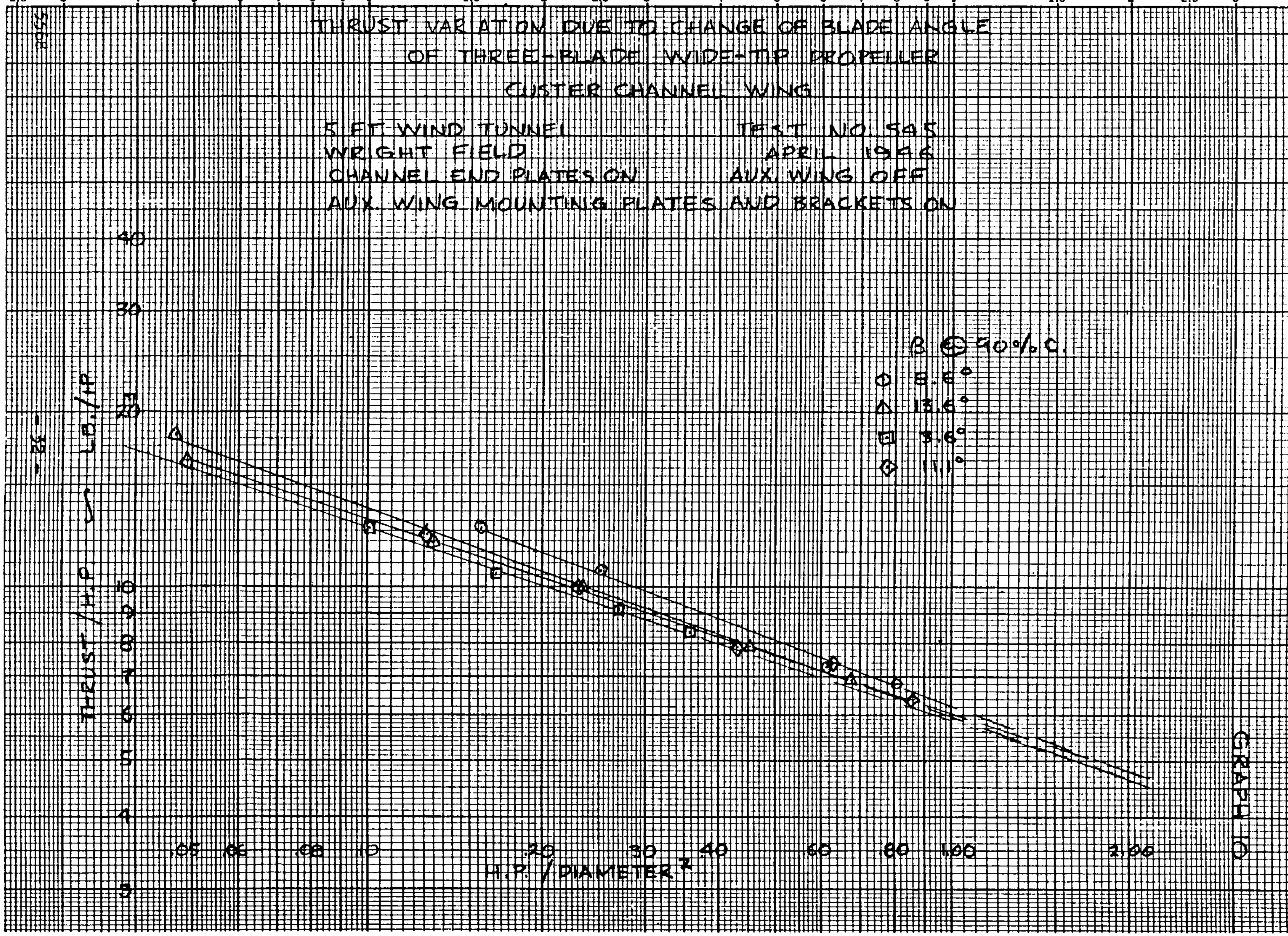

RESULTANT FORCE VARIATION DUE TO SINGLE AUXILIARY WING
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY 1946
2 BLADE THICK HUB WOODEN PROP
β = 20° @ 75%
SINGLE PANEL 25" x 36"
C.R. 12" AFT T.E.
DOUBLE PANEL 25" x 69"
○ SINGLE CENTER PANEL @ 45°, C.R. 1" BELOW T.L.
△ DOUBLE PANEL, RIGHT @ 55°, LEFT @ 40°, C.R. 2" BELOW T.L.
AUX. WING MOUNTING PLATES ON, BRACKETS OFF, END PLATES OFF
□ AUX. WING MOUNTING PLATES ON, BRACKETS OFF, CHANNEL END PLATES OFF
◇ PLATES OFF, BRACKETS ON, END PLATES OFF
+ PLATES OFF, BRACKETS ON, END PLATES ON
AUX. WINGS ON, RIGHT @ 55°, (DOUBLE PANEL) LEFT @ 42.5°, C.R. 4" BELOW T.L.
RESULTANT FORCE / H.P. → LB./HP
H.P. / DIAMETER²
GRAPH 7
5568



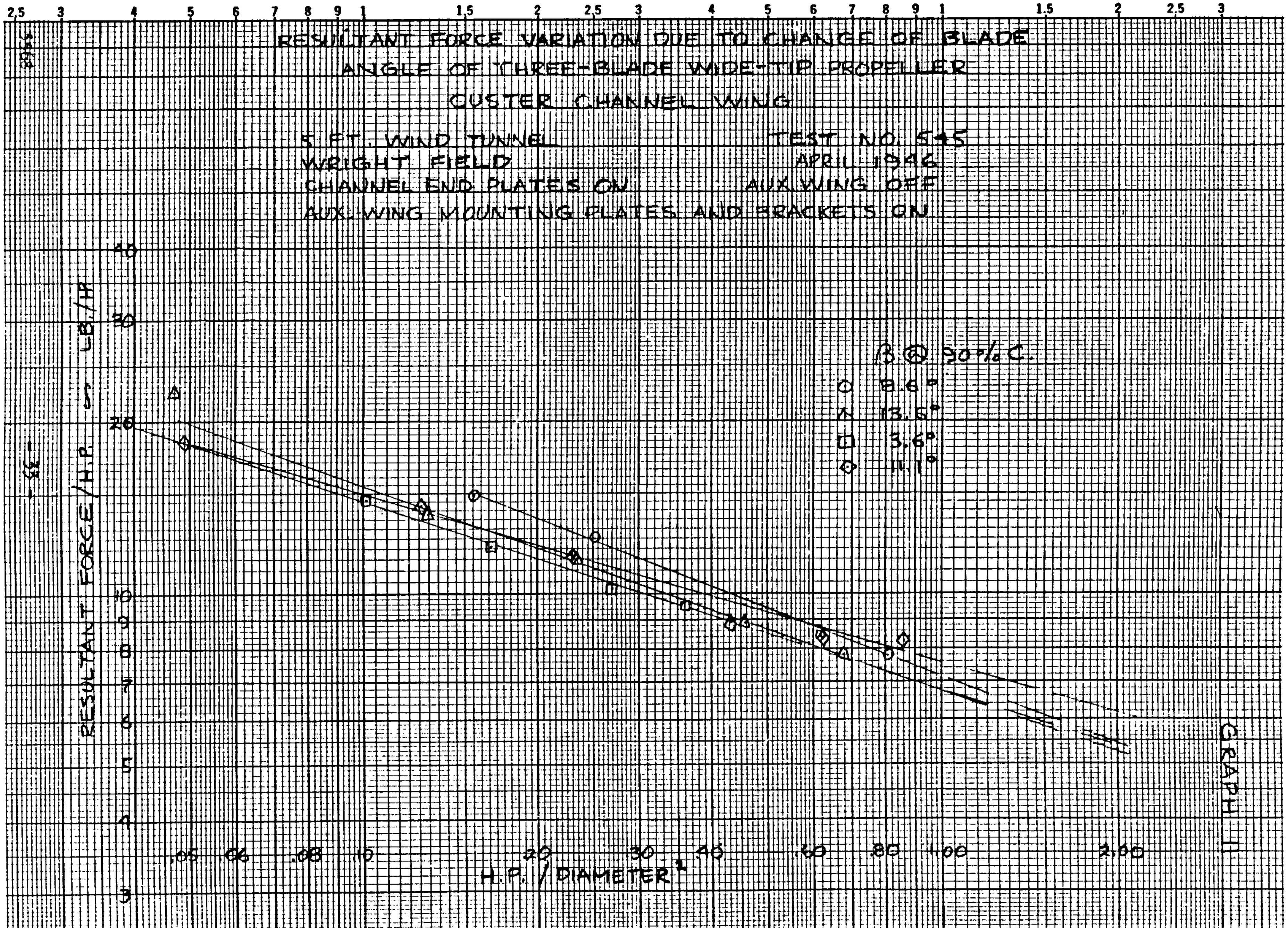
PITCHING MOMENT VARIATION DUE TO SINGLE AUXILIARY WING
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY 1946
2 BLADE THICK HUB WOODEN PROP
β = 20° @ 75%
SINGLE PANEL 25" X 36"
C.R. 12 AFT T.E.
DOUBLE PANEL 25" X 69"
⊙ SINGLE CENTER PANEL @ 45°, C.R. 1" BELOW T.L.
△ DOUBLE PANEL RIGHT @ 55°, LEFT @ 40°, C.R. 2" BELOW T.L.
AUX. WING MOUNTING PLATES ON, BRACKETS OFF, END PLATES OFF
□ AUX. WING MOUNTING PLATES ON, BRACKETS OFF, CHANNEL END PLATES OFF
◇ PLATES OFF, BRACKETS ON, END PLATES OFF
+ PLATES OFF, BRACKETS ON, END PLATES ON
AUX. WINGS ON: RIGHT @ 55° (DOUBLE PANEL) LEFT @ 42.5° C.R. 4" BELOW T.L.
PITCHING MOMENT / H.P. ~ FT. LB. / HP
H.P./DIAMETER²
GRAPH 8



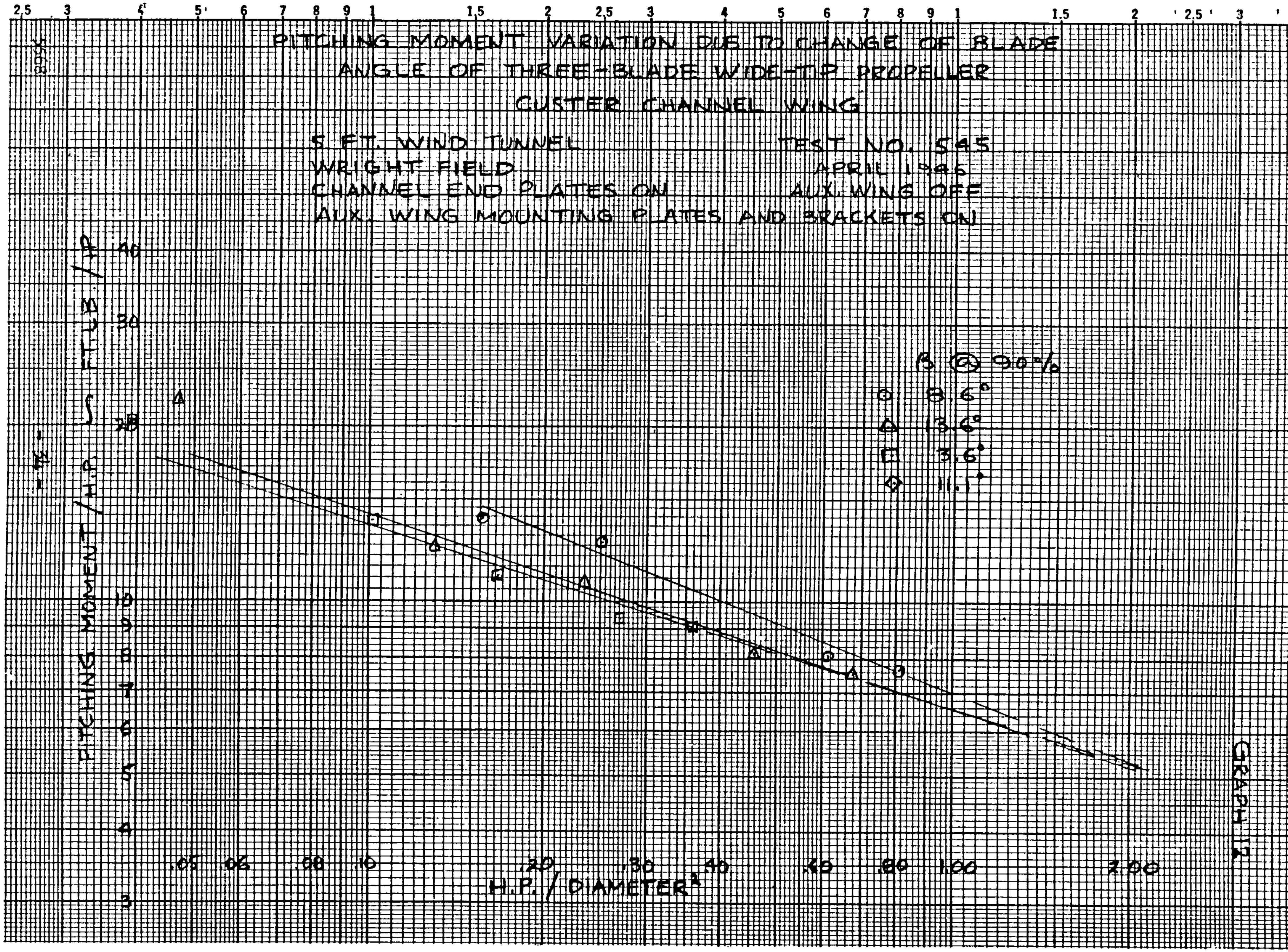
GRAPH 9
LIFT VARIATION DUE TO CHANGE OF BLADE ANGLE
OF THREE-BLADE WIDE-TIP PROPELLER
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL 1946
CHANNEL END PLATES ON
AUX WING OFF
AUX. WING MOUNTING PLATES AND BRACKETS ON
β @ 90% C.
8.6°
13.6°
3.6°
11.1°
LIFT / H.P.
LB/HP
H.P./DIAMETER²



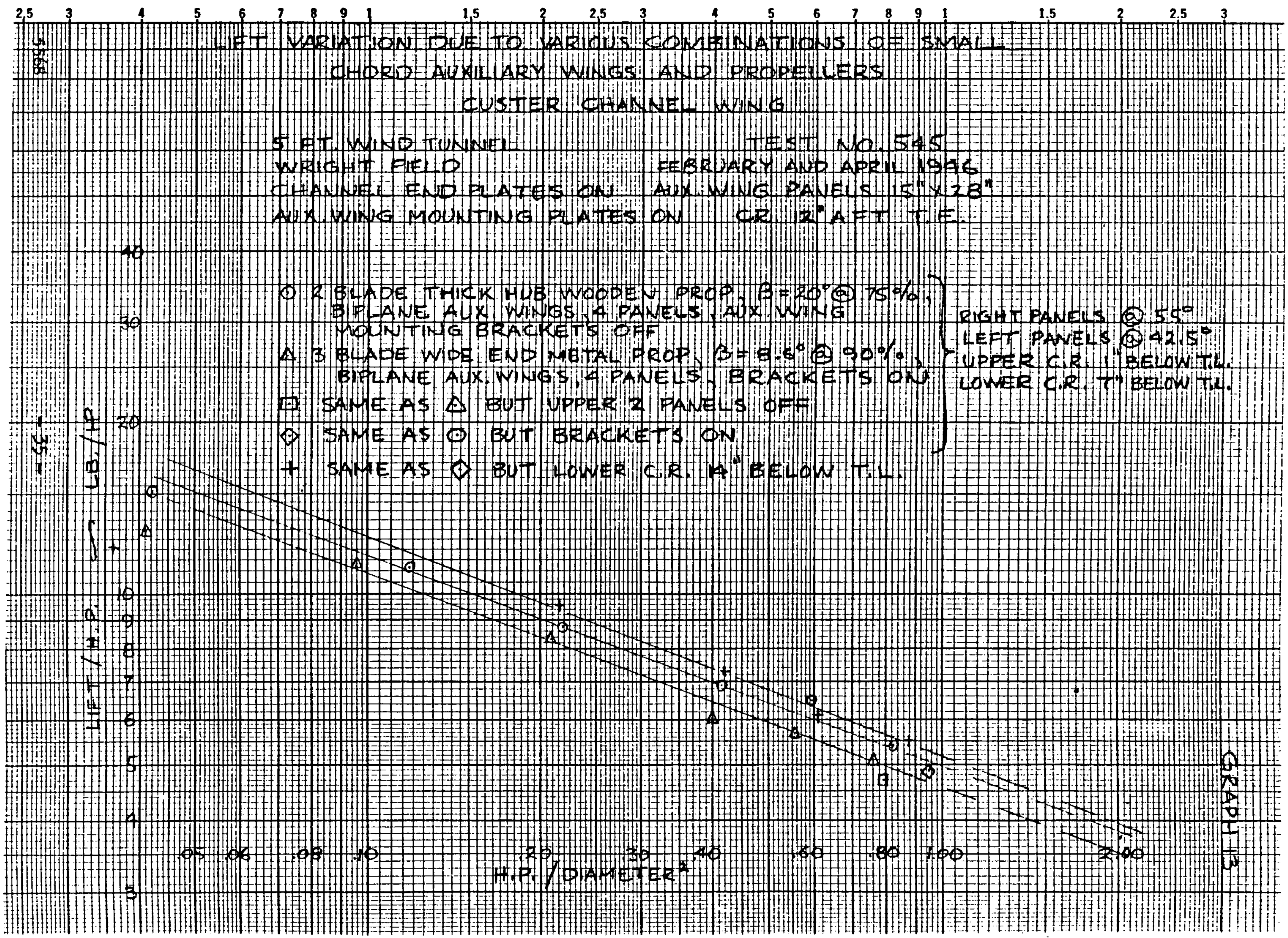
GRAPH 10
THRUST VARIATION DUE TO CHANGE OF BLADE ANGLE
OF THREE-BLADE WIDE-TIP PROPELLER
CUSTER CHANNEL WING
5 FT WIND TUNNEL
WRIGHT FIELD
CHANNEL END PLATES ON
AUX. WING MOUNTING PLATES AND BRACKETS ON
TEST NO 545
APRIL 1946
AUX. WING OFF
β @ 90% C.
8.6°
13.6°
3.6°
11°
THRUST / H.P. — LB./HP
H.P. / DIAMETER²
.05
.06
.08
.10
.20
.30
.40
.60
.80
1.00
2.00
3
4
5
6
7
8
9
10
20
30
40

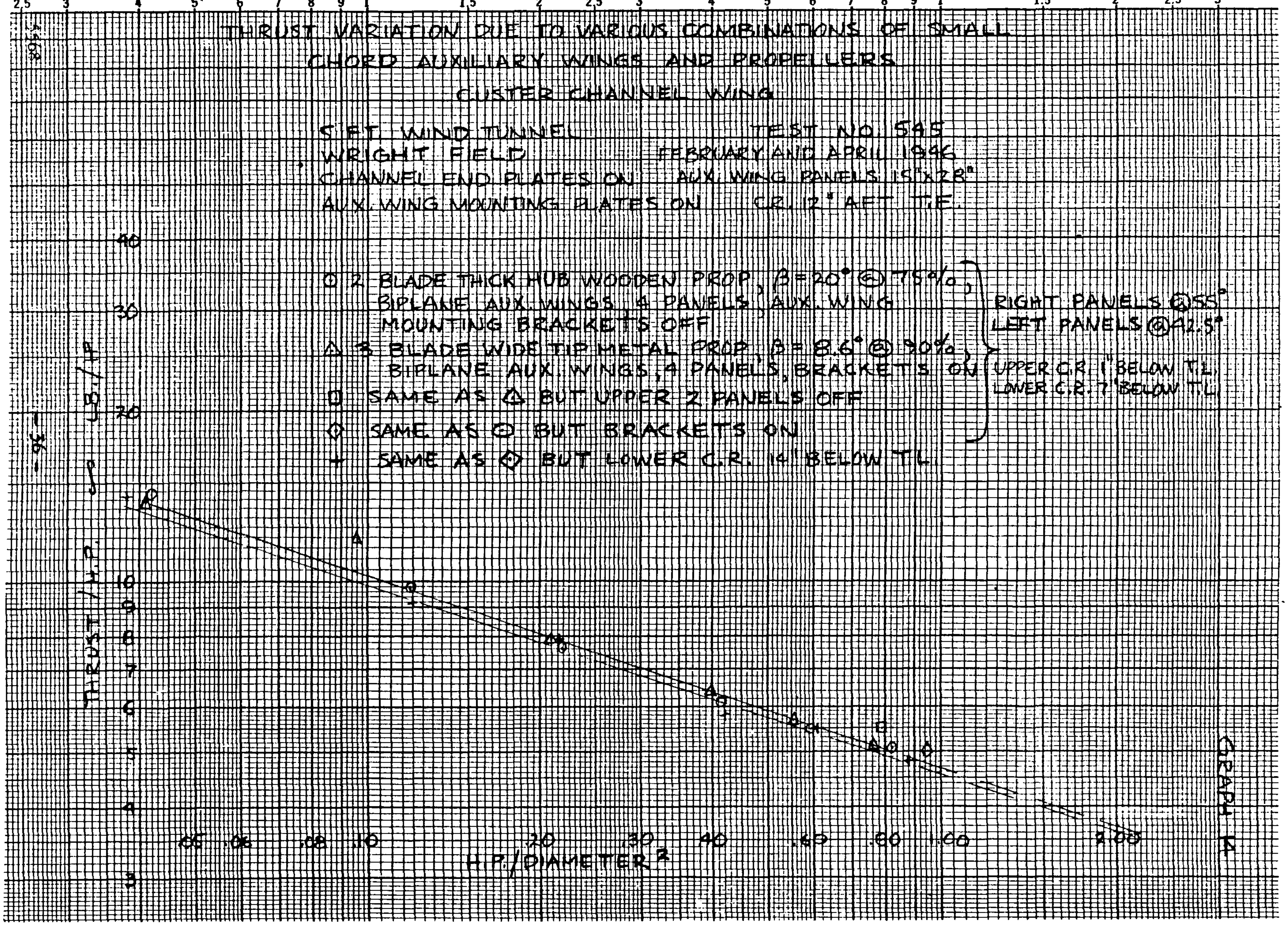


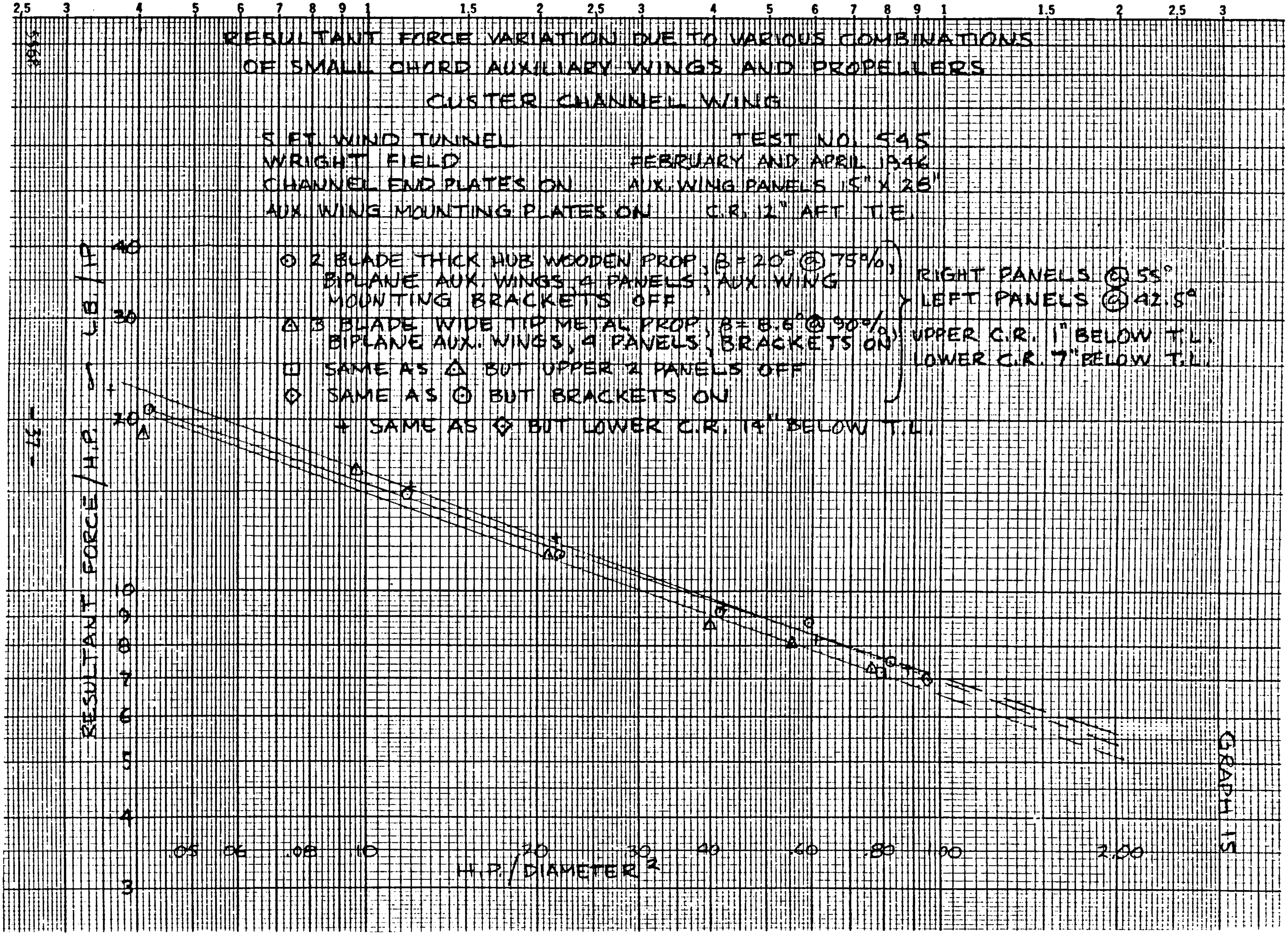
RESULTANT FORCE VARIATION DUE TO CHANGE OF BLADE
ANGLE OF THREE-BLADE WIDE-TIP PROPELLER
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL 1946
CHANNEL END PLATES ON
AUX WING OFF
AUX WING MOUNTING PLATES AND BRACKETS ON
β @ 90% C.
○ 8.6°
△ 13.6°
□ 3.6°
◇ 11.1°
RESULTANT FORCE/H.P. ~ LB./HP
H.P. / DIAMETER²
GRAPH 11

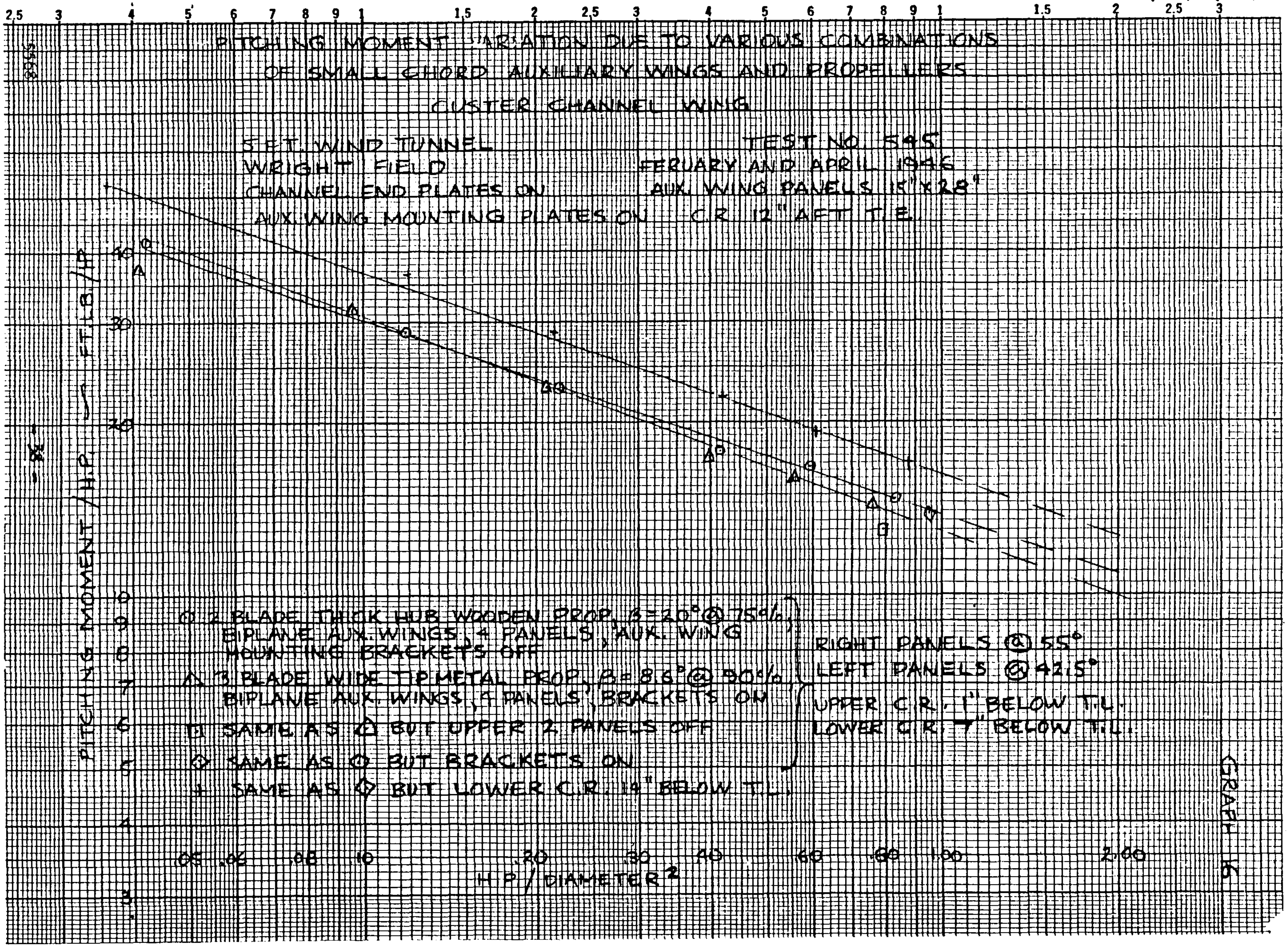


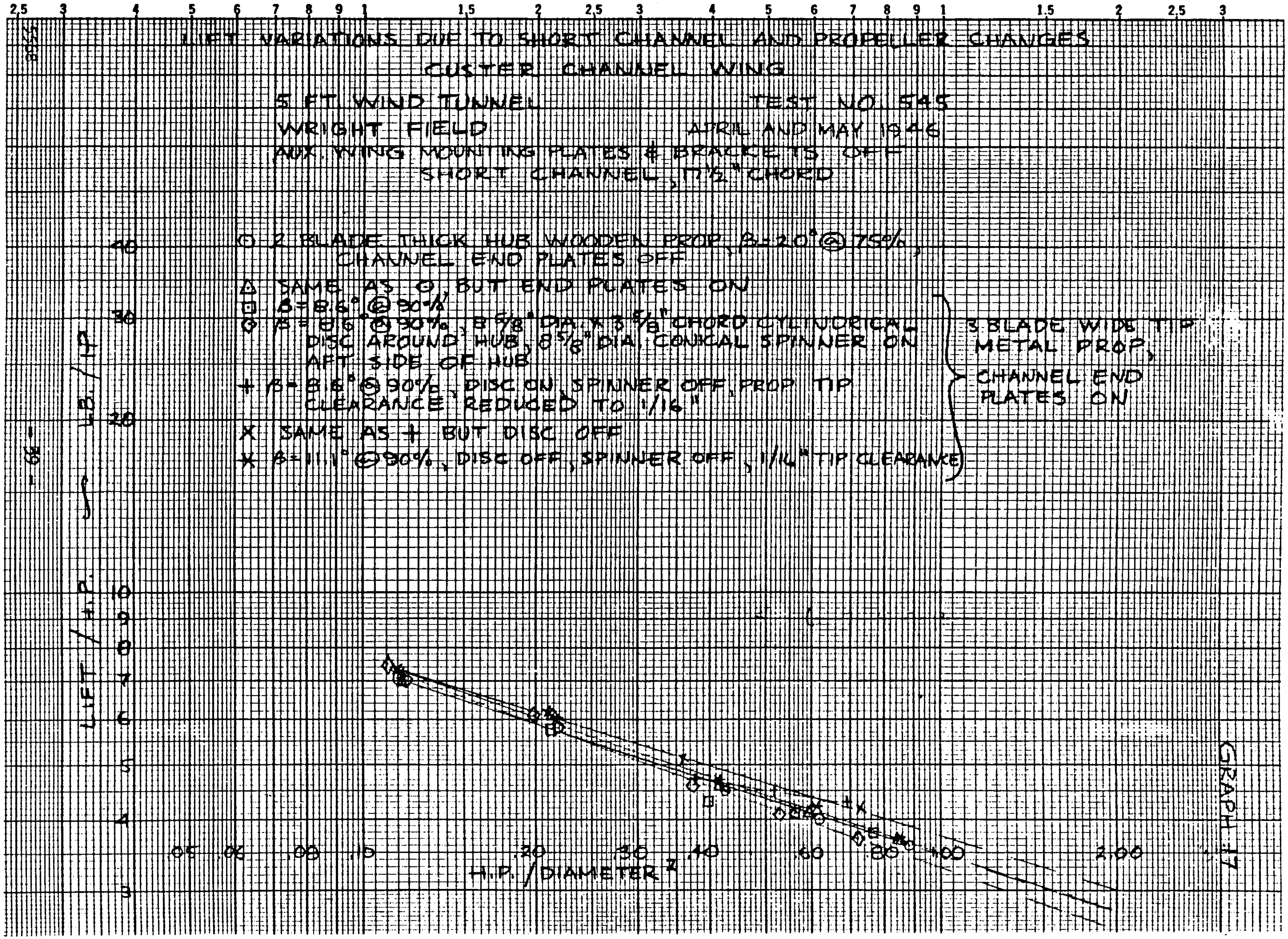
GRAPH 12
PITCHING MOMENT VARIATION DUE TO CHANGE OF BLADE
ANGLE OF THREE-BLADE WIDE-TIP PROPELLER
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL 1946
CHANNEL END PLATES ON
AUX. WING OFF
AUX. WING MOUNTING PLATES AND BRACKETS ON
β @ 90%
8.6°
13.6°
3.6°
11.1°
PITCHING MOMENT / H.P. FT. LB / HP
H.P. / DIAMETER²

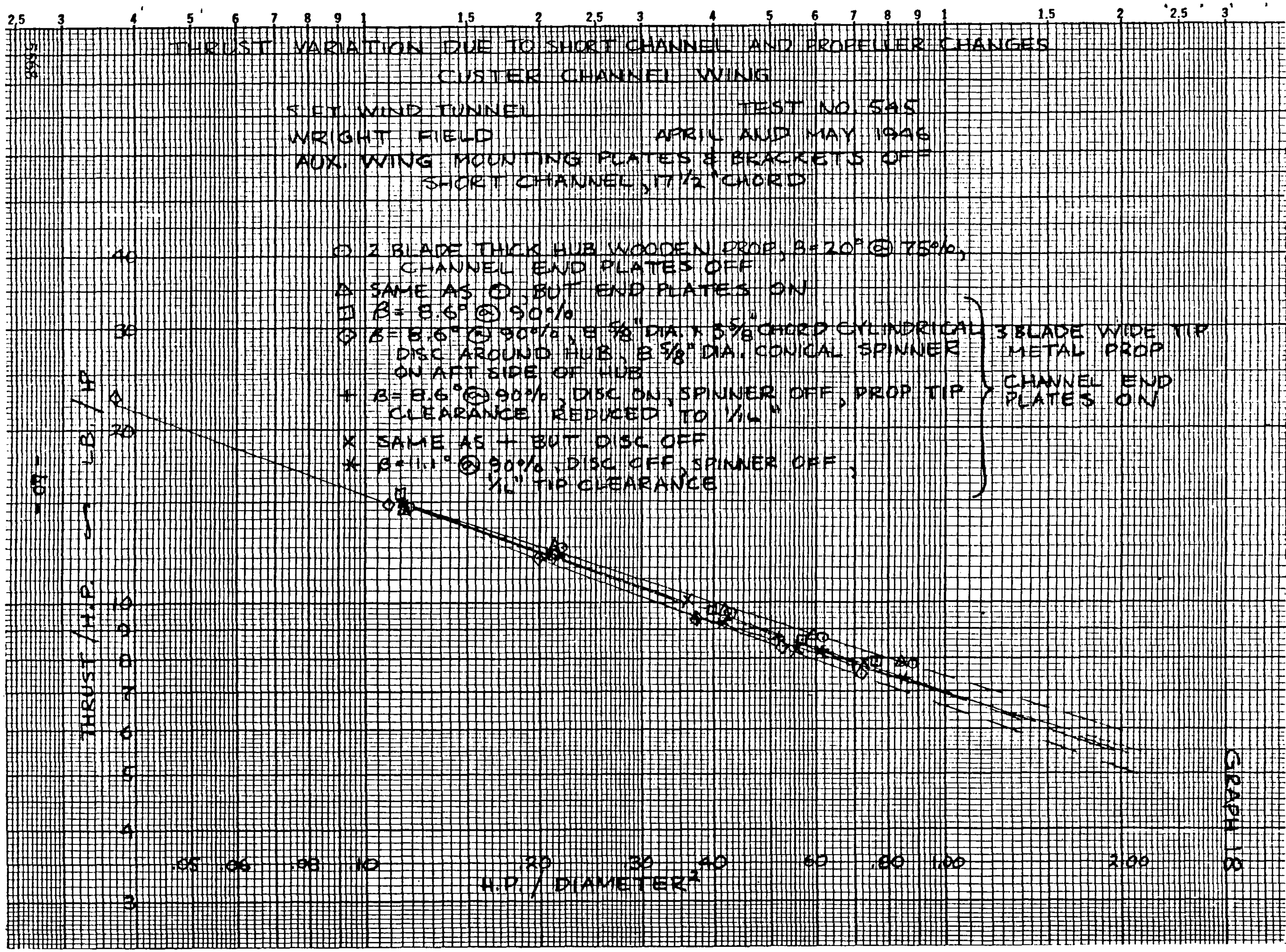

LIFT VARIATION DUE TO VARIOUS COMBINATIONS OF SMALL CHORD AUXILIARY WINGS AND PROPELLERS
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY AND APRIL 1946
CHANNEL END PLATES ON
AUX. WING PANELS 15" X 28"
AUX. WING MOUNTING PLATES ON
C.R. 12" AFT T.E.
⊙ 2 BLADE THICK HUB WOODEN PROP. β = 20° @ 75%, BIPLANE AUX. WINGS, 4 PANELS, AUX. WING MOUNTING BRACKETS OFF
△ 3 BLADE WIDE END METAL PROP. β = 8.6° @ 90%, BIPLANE AUX. WINGS, 4 PANELS, BRACKETS ON
□ SAME AS △ BUT UPPER 2 PANELS OFF
◇ SAME AS ⊙ BUT BRACKETS ON
+ SAME AS ◇ BUT LOWER C.R. 14" BELOW T.L.
RIGHT PANELS @ 55°
LEFT PANELS @ 42.5°
UPPER C.R. 1" BELOW T.L.
LOWER C.R. 7" BELOW T.L.
LIFT / H.P. ∫ LB./HP
H.P. / DIAMETER²
GRAPH 13
5568

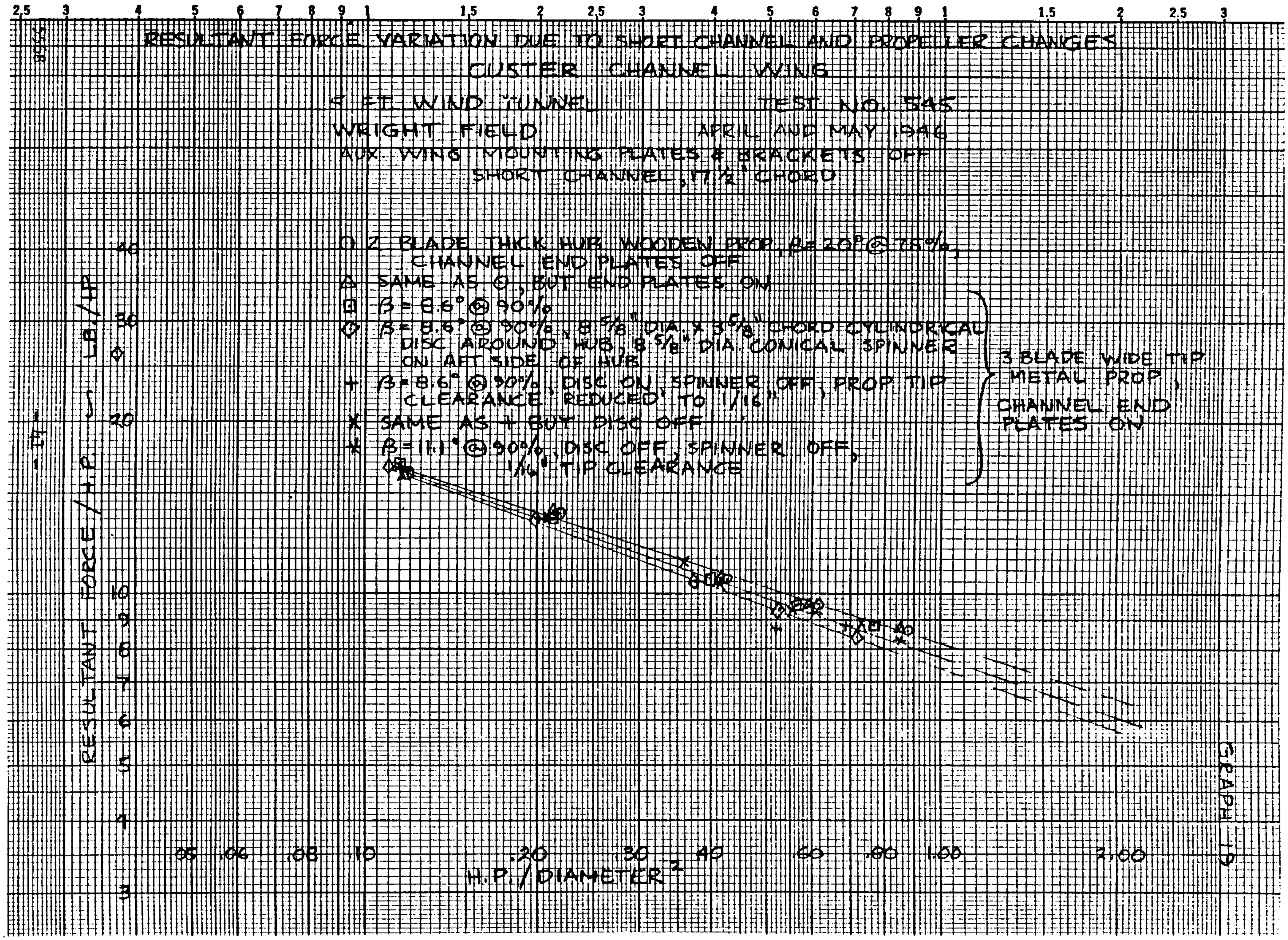

THRUST VARIATION DUE TO VARIOUS COMBINATIONS OF SMALL
CHORD AUXILIARY WINGS AND PROPELLERS
CUSTER CHANNEL WING
5 FT WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY AND APRIL 1946
CHANNEL END PLATES ON
AUX. WING PANELS 15"x28"
AUX. WING MOUNTING PLATES ON
C.R. 12" AFT T.E.
○ 2 BLADE THICK HUB WOODEN PROP, β = 20° @ 75%,
BIPLANE AUX. WINGS, 4 PANELS, AUX. WING
MOUNTING BRACKETS OFF
△ 3 BLADE WIDE TIP METAL PROP, β = 8.6° @ 90%,
BIPLANE AUX. WINGS, 4 PANELS, BRACKETS ON
□ SAME AS △ BUT UPPER 2 PANELS OFF
◇ SAME AS ○ BUT BRACKETS ON
+ SAME AS ◇ BUT LOWER C.R. 14" BELOW T.L.
RIGHT PANELS @ 55°
LEFT PANELS @ 42.5°
UPPER C.R. 1" BELOW T.L.
LOWER C.R. 7" BELOW T.L.
THRUST / H.P.
C_T / J
H.P./DIAMETER²
GRAPH 14
40
30
20
10
9
8
7
6
5
4
3
.05
.06
.08
.10
.20
.30
.40
.60
.80
1.00
2.00

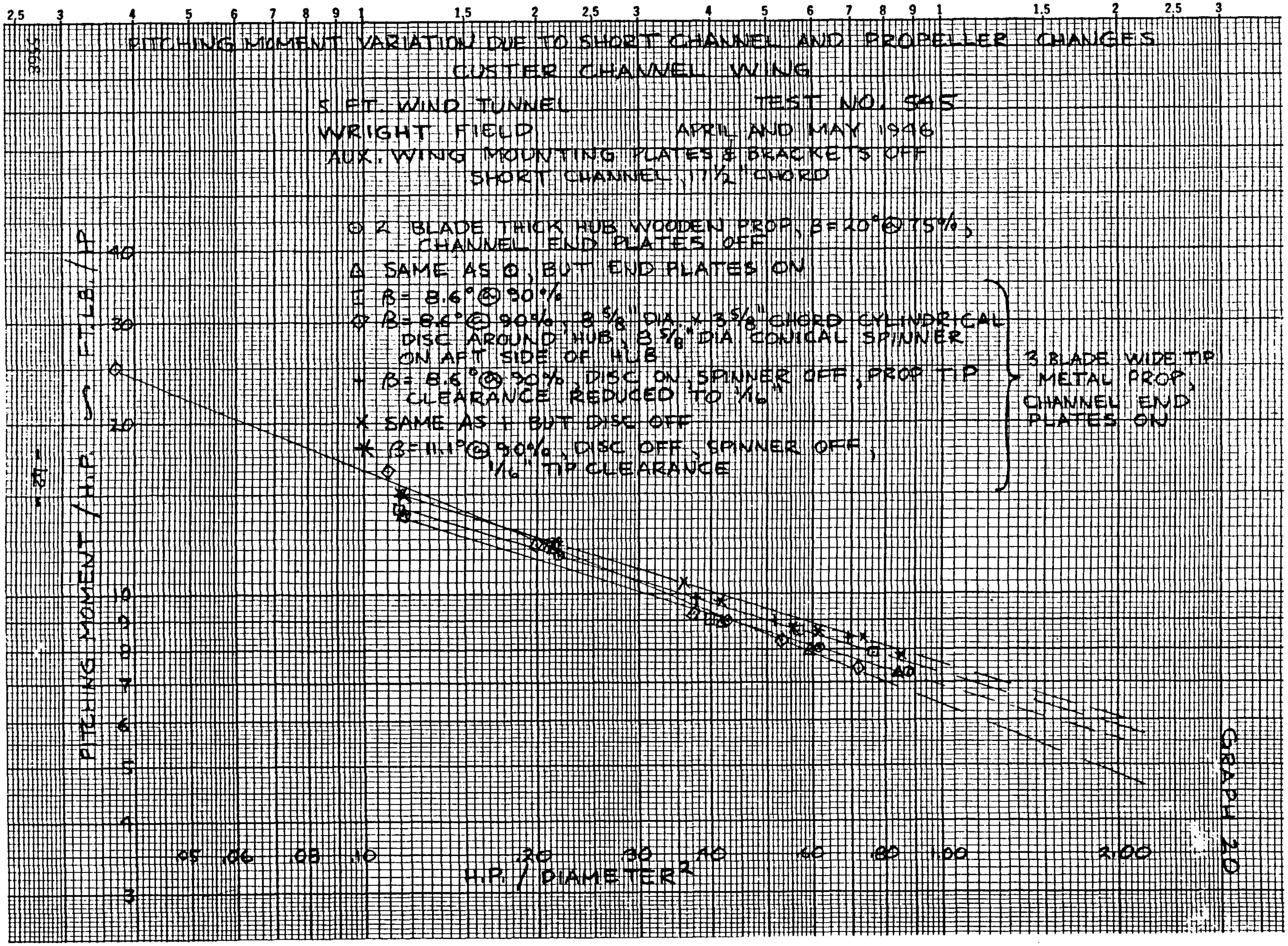

RESULTANT FORCE VARIATION DUE TO VARIOUS COMBINATIONS
OF SMALL CHORD AUXILIARY WINGS AND PROPELLERS
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
FEBRUARY AND APRIL 1946
CHANNEL END PLATES ON
AUX. WING PANELS 15" X 25"
AUX. WING MOUNTING PLATES ON
C.R. 12" AFT T.E.
⊙ 2 BLADE THICK HUB WOODEN PROP., β = 20° @ 75%, BIPLANE AUX. WINGS, 4 PANELS, AUX. WING MOUNTING BRACKETS OFF
△ 3 BLADE WIDE TIP METAL PROP., β = 8.6° @ 90%, BIPLANE AUX. WINGS, 4 PANELS, BRACKETS ON
□ SAME AS △ BUT UPPER 2 PANELS OFF
◇ SAME AS ⊙ BUT BRACKETS ON
+ SAME AS ◇ BUT LOWER C.R. 14" BELOW T.L.
RIGHT PANELS @ 55°
LEFT PANELS @ 42.5°
UPPER C.R. 1" BELOW T.L.
LOWER C.R. 7" BELOW T.L.
RESULTANT FORCE / H.P. LB./H.P.
H.P./DIAMETER²
GRAPH 15


PITCHING MOMENT VARIATION DUE TO VARIOUS COMBINATIONS
OF SMALL CHORD AUXILIARY WINGS AND PROPELLERS
CUSTER CHANNEL WING
5 F.T. WIND TUNNEL
WRIGHT FIELD
CHANNEL END PLATES ON
AUX. WING MOUNTING PLATES ON
TEST NO. 545
FERUARY AND APRIL 1946
AUX. WING PANELS 15"X28"
C.R. 12" AFT T.E.
⊙ 2 BLADE THICK HUB WOODEN PROP. β=20° @ 75%
BIPLANE AUX. WINGS, 4 PANELS, AUX. WING MOUNTING BRACKETS OFF
△ 3 BLADE WIDE TIP METAL PROP. β=8.6° @ 90%
BIPLANE AUX. WINGS, 4 PANELS, BRACKETS ON
□ SAME AS △ BUT UPPER 2 PANELS OFF
◇ SAME AS ⊙ BUT BRACKETS ON
+ SAME AS ◇ BUT LOWER C.R. 14" BELOW T.L.
RIGHT PANELS @ 55°
LEFT PANELS @ 42.5°
UPPER C.R. 1" BELOW T.L.
LOWER C.R. 7" BELOW T.L.
PITCHING MOMENT / H.P. — FT.LB./H.P.
H.P. / DIAMETER²
GRAPH 16

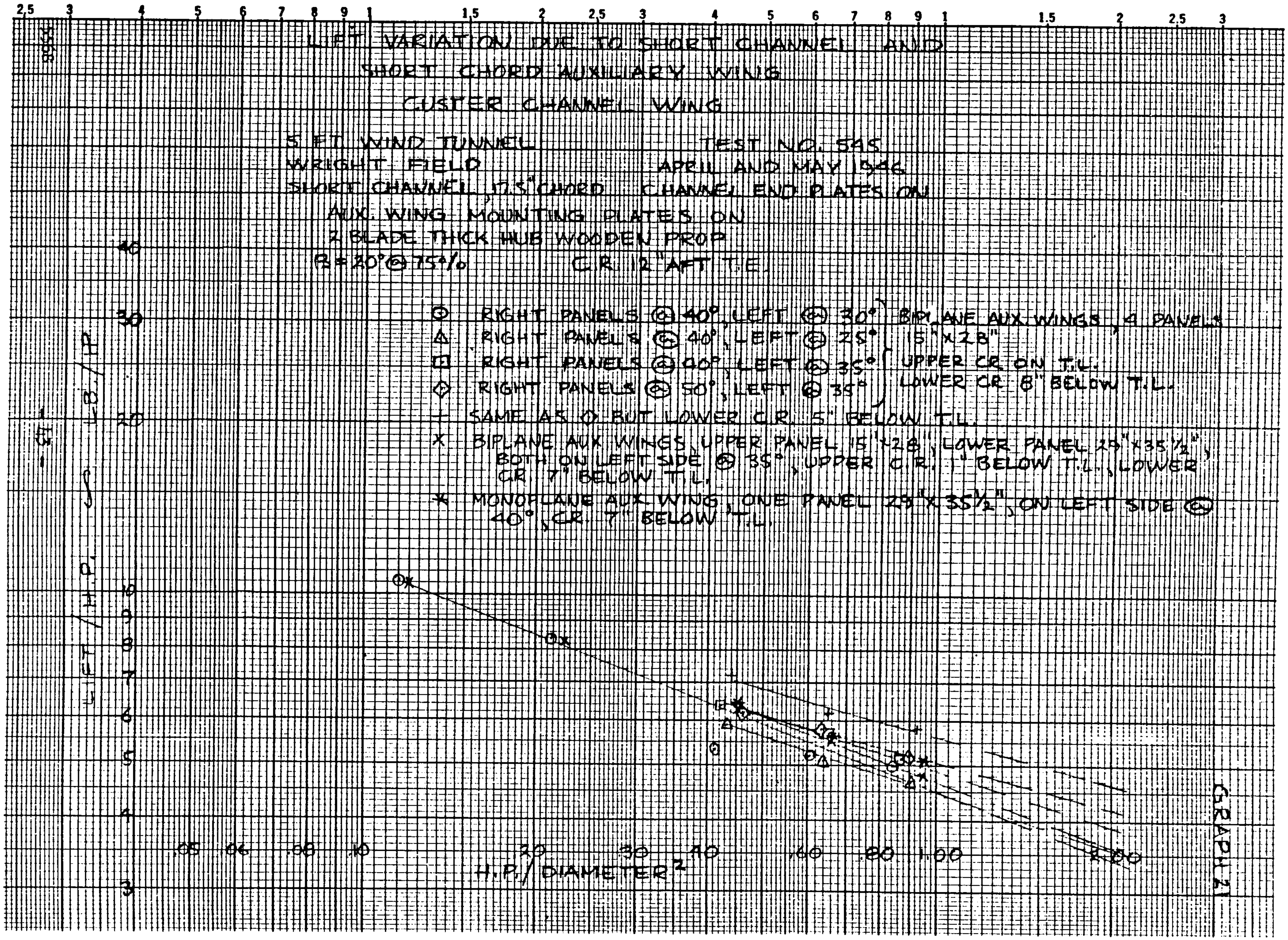

LIFT VARIATIONS DUE TO SHORT CHANNEL AND PROPELLER CHANGES
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL AND MAY 1946
AUX. WING MOUNTING PLATES & BRACKETS OFF
SHORT CHANNEL, 17½" CHORD
⊙ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF
△ SAME AS ⊙, BUT END PLATES ON
⊡ β=8.6° @ 90%
◇ β=8.6° @ 90%, 8 7/8" DIA. X 3 5/8" CHORD CYLINDRICAL DISC AROUND HUB, 8 5/8" DIA. CONICAL SPINNER ON AFT SIDE OF HUB
+ β=8.6° @ 90%, DISC ON, SPINNER OFF, PROP TIP CLEARANCE REDUCED TO 1/16"
X SAME AS + BUT DISC OFF
✳ β=11.1° @ 90%, DISC OFF, SPINNER OFF, 1/16" TIP CLEARANCE
3 BLADE WIDE TIP METAL PROP, CHANNEL END PLATES ON
LIFT / H.P. ∫ LB./HP
H.P./DIAMETER²
GRAPH 17

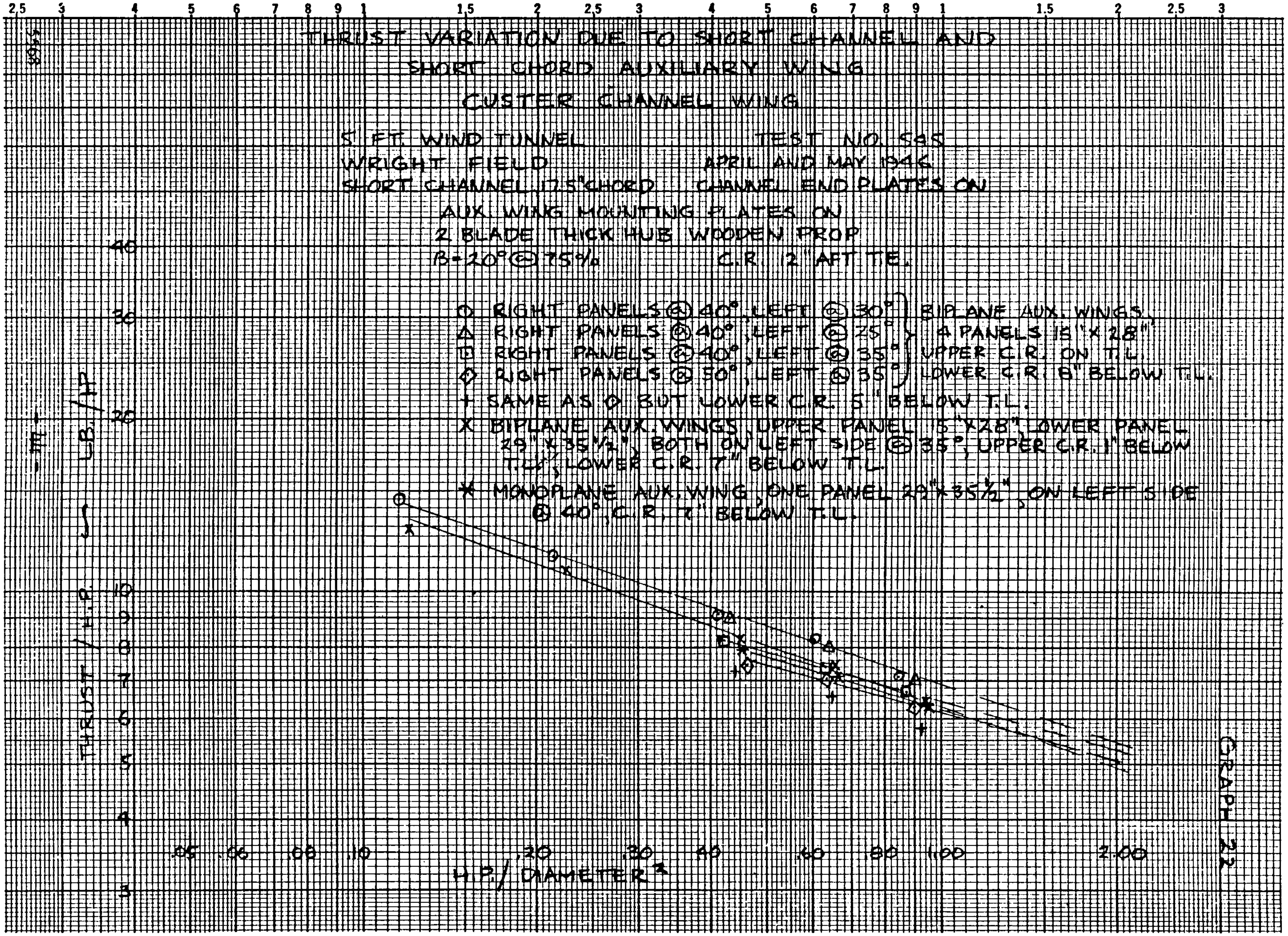

THRUST VARIATION DUE TO SHORT CHANNEL AND PROPELLER CHANGES
CUSTER CHANNEL WING
5'FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL AND MAY 1946
AUX. WING MOUNTING PLATES & BRACKETS OFF
SHORT CHANNEL, 17½" CHORD
○ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF
△ SAME AS ○, BUT END PLATES ON
□ β= 8.6° @ 90%
◇ β= 8.6° @ 90%, 8 5/8" DIA. x 3 5/8" CHORD CYLINDRICAL DISC AROUND HUB, 8 5/8" DIA. CONICAL SPINNER ON AFT SIDE OF HUB
+ β= 8.6° @ 90%, DISC ON, SPINNER OFF, PROP TIP CLEARANCE REDUCED TO 1/16"
× SAME AS + BUT DISC OFF
✱ β=11.1° @ 90%, DISC OFF, SPINNER OFF, 1/16" TIP CLEARANCE
3 BLADE WIDE TIP METAL PROP
CHANNEL END PLATES ON
THRUST / H.P. — LB./HP
H.P. / DIAMETER²
GRAPH 18

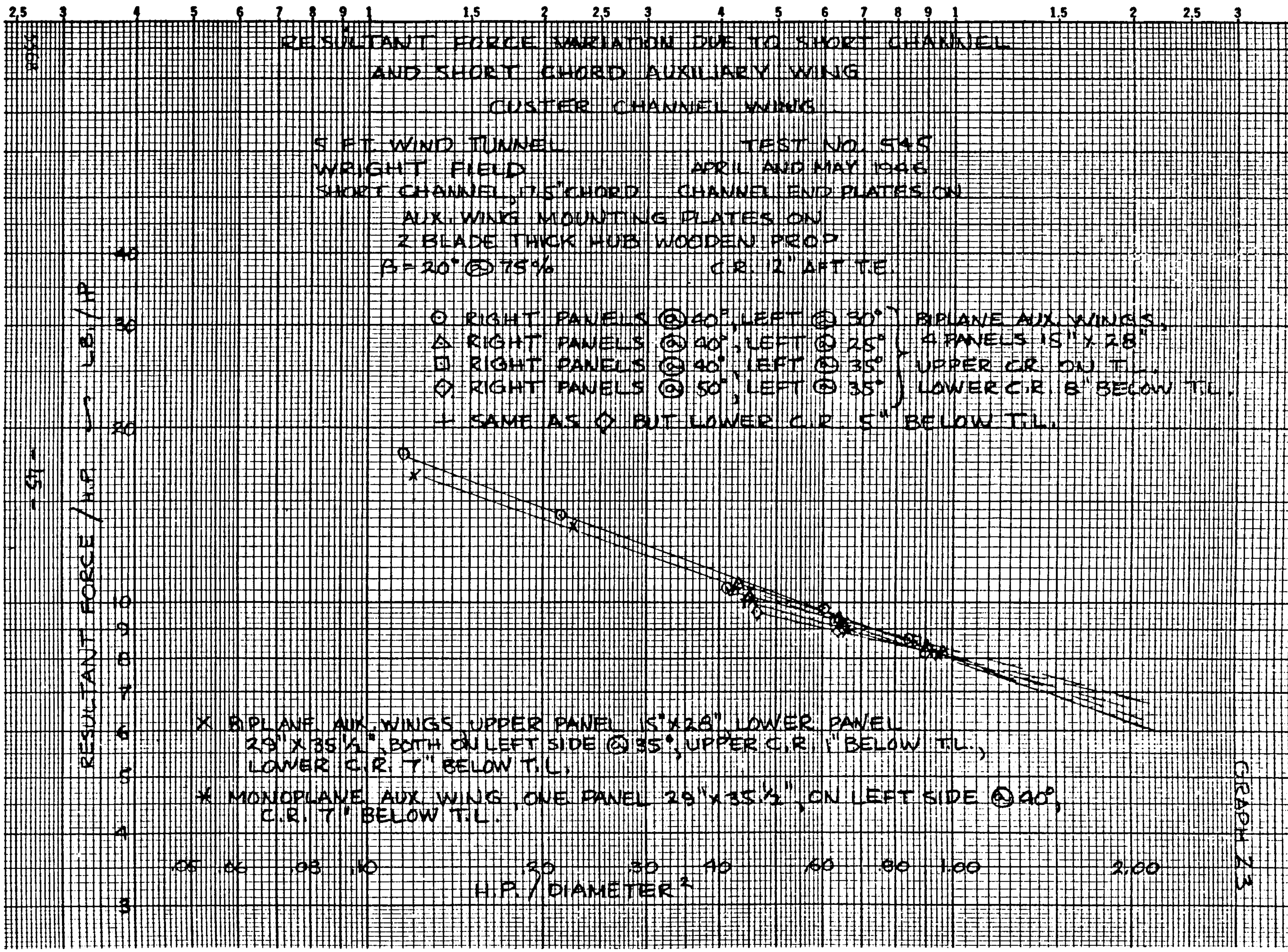

RESULTANT FORCE VARIATION DUE TO SHORT CHANNEL AND PROPELLER CHANGES
CUSTER CHANNEL WING
4 FT WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL AND MAY 1946
AUX. WING MOUNTING PLATES & BRACKETS OFF
SHORT CHANNEL, 17½" CHORD
O 2 BLADE THICK HUB WOODEN PROP, β = 20° @ 75%, CHANNEL END PLATES OFF
△ SAME AS O, BUT END PLATES ON
□ β = 8.6° @ 90%
◇ β = 8.6° @ 90%, 8 5/8" DIA. X 3 5/8" CHORD CYLINDRICAL DISC AROUND HUB, 8 5/8" DIA. CONICAL SPINNER ON AFT SIDE OF HUB
+ β = 8.6° @ 90%, DISC ON, SPINNER OFF, PROP TIP CLEARANCE REDUCED TO 1/16"
X SAME AS + BUT DISC OFF
✳ β = 11.1° @ 90%, DISC OFF, SPINNER OFF, 1/16" TIP CLEARANCE
3 BLADE WIDE TIP METAL PROP, CHANNEL END PLATES ON
RESULTANT FORCE / H.P. — LB./HP
H.P. / DIAMETER²
GRAPH 19

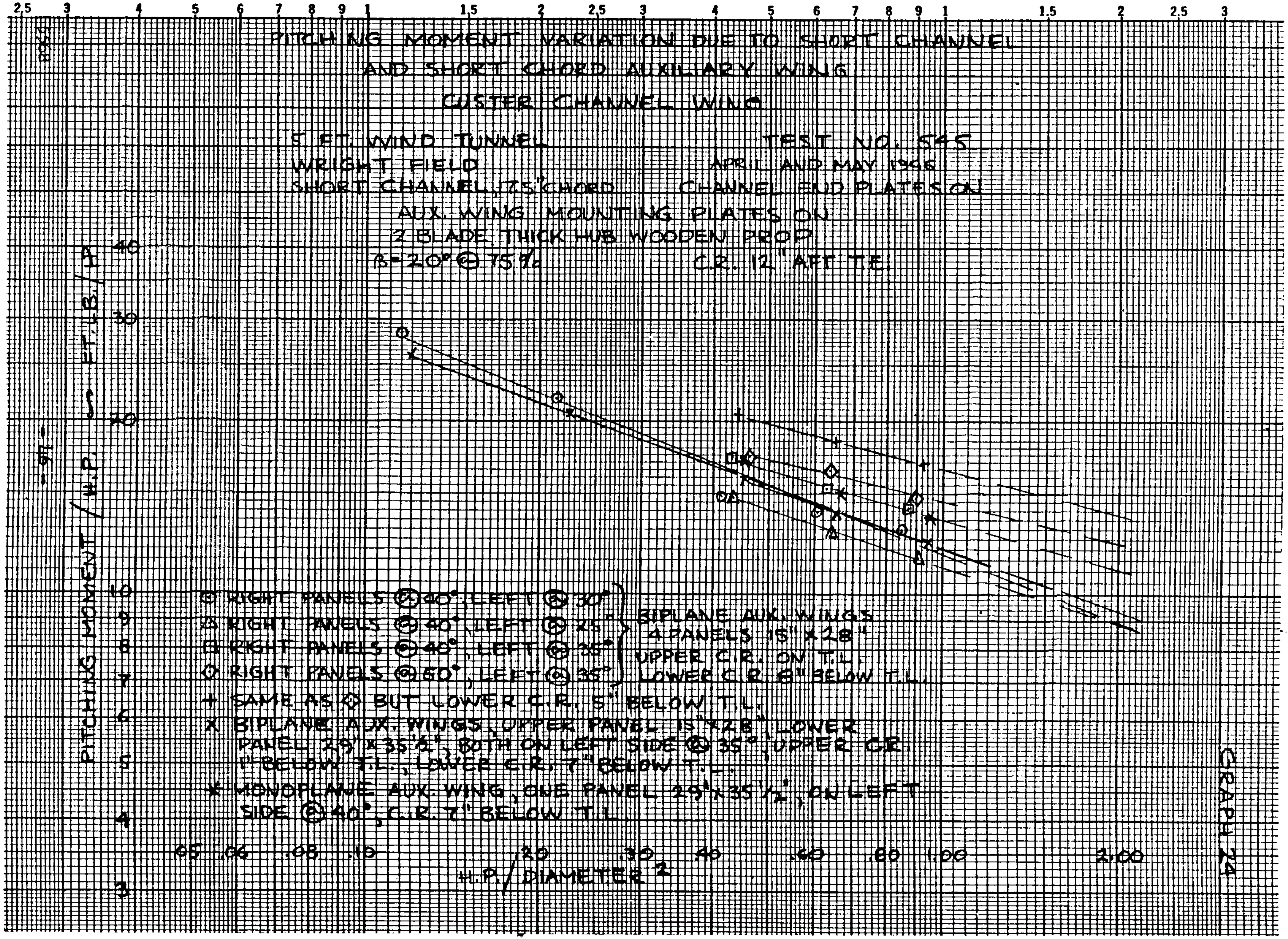


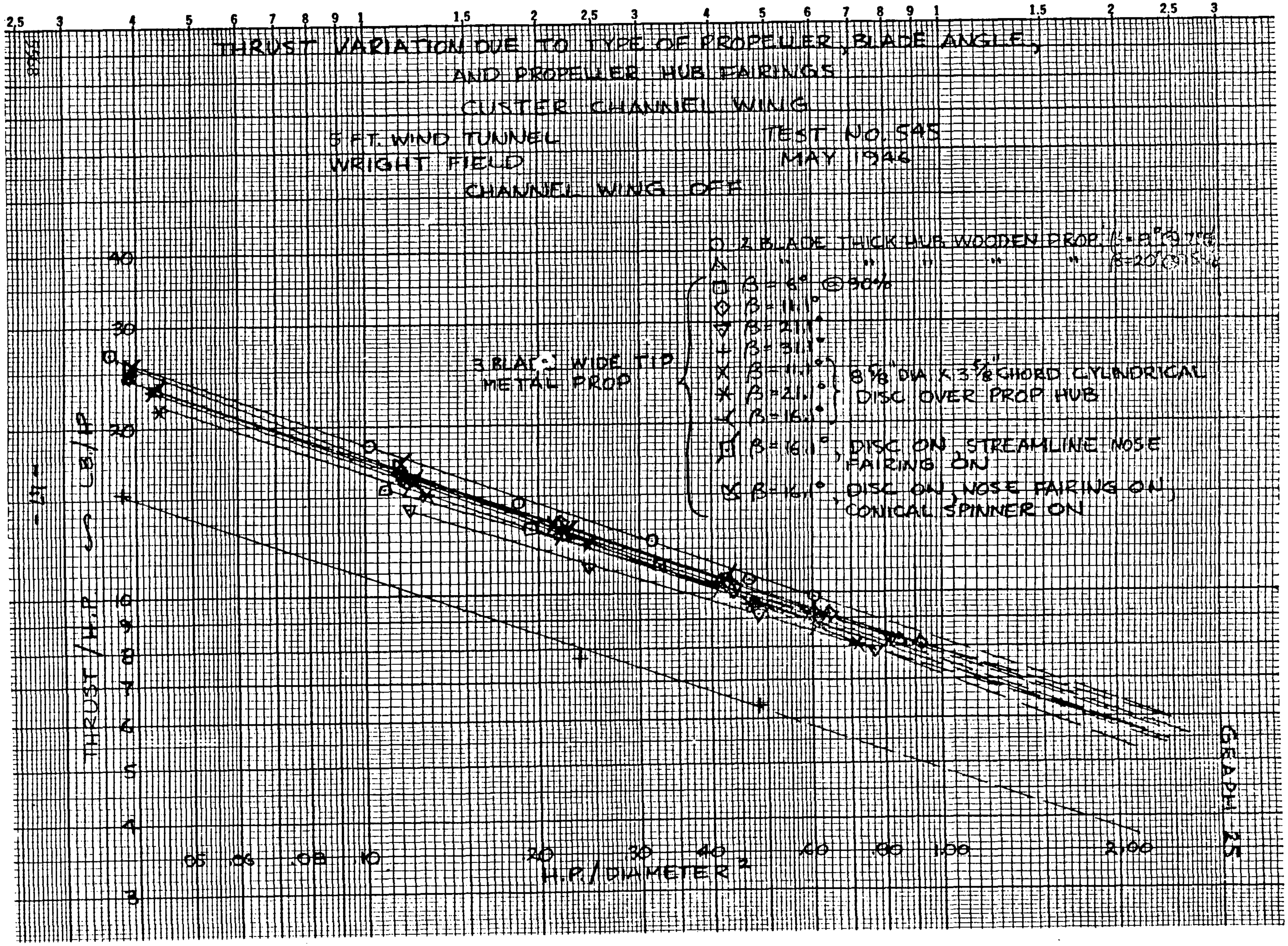
PITCHING MOMENT VARIATION DUE TO SHORT CHANNEL AND PROPELLER CHANGES
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL AND MAY 1946
AUX. WING MOUNTING PLATES & BRACKETS OFF
SHORT CHANNEL, 17½" CHORD
⊙ 2 BLADE THICK HUB WOODEN PROP, β=20° @ 75%, CHANNEL END PLATES OFF
△ SAME AS ⊙, BUT END PLATES ON
□ β= 8.6° @ 90%
◇ β= 8.6° @ 90%, 8 5/8" DIA. x 3 5/8" CHORD CYLINDRICAL DISC AROUND HUB, 8 5/8" DIA CONICAL SPINNER ON AFT SIDE OF HUB
+ β= 8.6° @ 90%, DISC ON, SPINNER OFF, PROP TIP CLEARANCE REDUCED TO 1/16"
× SAME AS + BUT DISC OFF
✳ β=11.1° @ 90%, DISC OFF, SPINNER OFF, 1/16" TIP CLEARANCE
3 BLADE WIDE TIP METAL PROP, CHANNEL END PLATES ON
PITCHING MOMENT / H.P. ~ FT. LB. / HP
H.P. / DIAMETER²
GRAPH 20


LIFT VARIATION DUE TO SHORT CHANNEL AND
SHORT CHORD AUXILIARY WING
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL AND MAY 1946
SHORT CHANNEL 17.5" CHORD
CHANNEL END PLATES ON
AUX. WING MOUNTING PLATES ON
2 BLADE THICK HUB WOODEN PROP
β = 20° @ 75%
C.R. 12" AFT T.E.
⊙ RIGHT PANELS @ 40°, LEFT @ 30°
△ RIGHT PANELS @ 40°, LEFT @ 25°
□ RIGHT PANELS @ 40°, LEFT @ 35°
◇ RIGHT PANELS @ 50°, LEFT @ 35°
BIPLANE AUX. WINGS, 4 PANELS
15" x 28"
UPPER C.R. ON T.L.
LOWER C.R. 8" BELOW T.L.
+ SAME AS ◇ BUT LOWER C.R. 5" BELOW T.L.
X BIPLANE AUX WINGS, UPPER PANEL 15" x 28", LOWER PANEL 29" x 35½",
BOTH ON LEFT SIDE @ 35°, UPPER C.R. 1" BELOW T.L., LOWER
C.R. 7" BELOW T.L.
✱ MONOPLANE AUX. WING, ONE PANEL 29" x 35½", ON LEFT SIDE @
40°, C.R. 7" BELOW T.L.
LIFT / H.P., LB / HP
H.P. / DIAMETER²
.05
.06
.08
.10
.20
.30
.40
.60
.80
1.00
2.00
3
4
5
6
7
8
9
10
20
30
40
GRAPH 21
5568

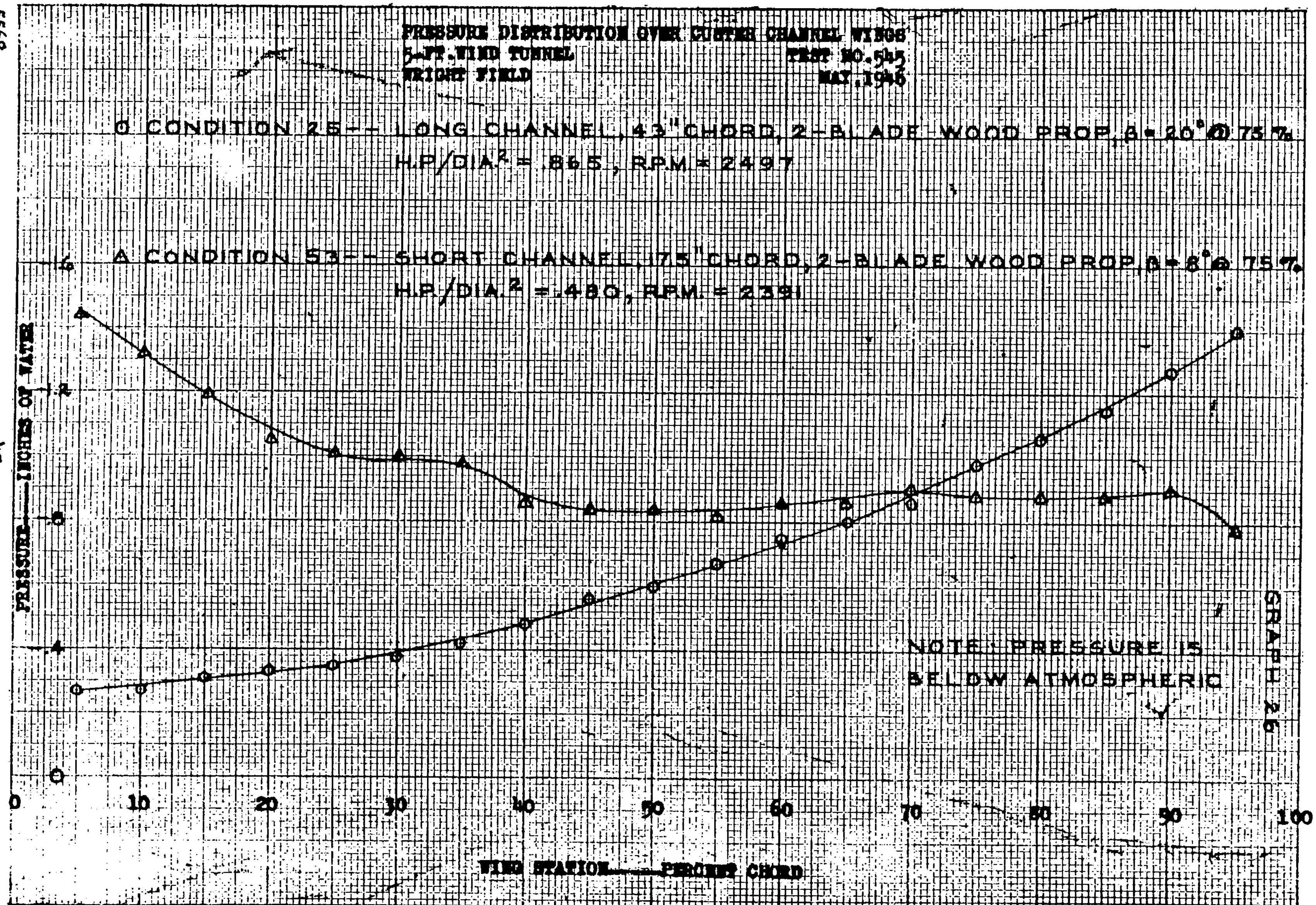

THRUST VARIATION DUE TO SHORT CHANNEL AND
SHORT CHORD AUXILIARY WING
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL AND MAY 1946
SHORT CHANNEL 17.5" CHORD
CHANNEL END PLATES ON
AUX. WING MOUNTING PLATES ON
2 BLADE THICK HUB WOODEN PROP
β=20° @ 75%
C.R. 2" AFT T.E.
○ RIGHT PANELS @ 40°, LEFT @ 30°
△ RIGHT PANELS @ 40°, LEFT @ 25°
□ RIGHT PANELS @ 40°, LEFT @ 35°
◇ RIGHT PANELS @ 50°, LEFT @ 35°
BIPLANE AUX. WINGS.
4 PANELS 15" x 28"
UPPER C.R. ON T.L.
LOWER C.R. 8" BELOW T.L.
+ SAME AS ◇ BUT LOWER C.R. 5" BELOW T.L.
X BIPLANE AUX. WINGS, UPPER PANEL 15" X 28", LOWER PANEL 29" X 35½", BOTH ON LEFT SIDE @ 35°, UPPER C.R. 1" BELOW T.L., LOWER C.R. 7" BELOW T.L.
✱ MONOPLANE AUX. WING, ONE PANEL 29" X 35½", ON LEFT SIDE @ 40°, C.R. 7" BELOW T.L.
THRUST / H.P. — LB./HP
H.P./DIAMETER²
GRAPH 22


GRAPH 23
RESULTANT FORCE VARIATION DUE TO SHORT CHANNEL
AND SHORT CHORD AUXILIARY WING
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL AND MAY 1946
SHORT CHANNEL, 17.5" CHORD
CHANNEL END PLATES ON
AUX. WING MOUNTING PLATES ON
2 BLADE THICK HUB WOODEN PROP
β = 20° @ 75%
C.R. 12" AFT T.E.
⊙ RIGHT PANELS @ 40°, LEFT @ 30°
△ RIGHT PANELS @ 40°, LEFT @ 25°
□ RIGHT PANELS @ 40°, LEFT @ 35°
◇ RIGHT PANELS @ 50°, LEFT @ 35°
BIPLANE AUX. WINGS, 4 PANELS 15" X 28" UPPER C.R. ON T.L. LOWER C.R. 8" BELOW T.L.
+ SAME AS ◇ BUT LOWER C.R. 5" BELOW T.L.
X BIPLANE AUX. WINGS UPPER PANEL 15" X 28", LOWER PANEL 29" X 35 1/2", BOTH ON LEFT SIDE @ 35°, UPPER C.R. 1" BELOW T.L., LOWER C.R. 7" BELOW T.L.
✳ MONOPLANE AUX. WING, ONE PANEL 29" X 35 1/2", ON LEFT SIDE @ 40°, C.R. 7" BELOW T.L.
RESULTANT FORCE / H.P. — LB./H.P.
H.P. / DIAMETER²
.05
.06
.08
.10
.20
.30
.40
.60
.80
1.00
2.00
3
4
5
6
7
8
9
10
20
30
40

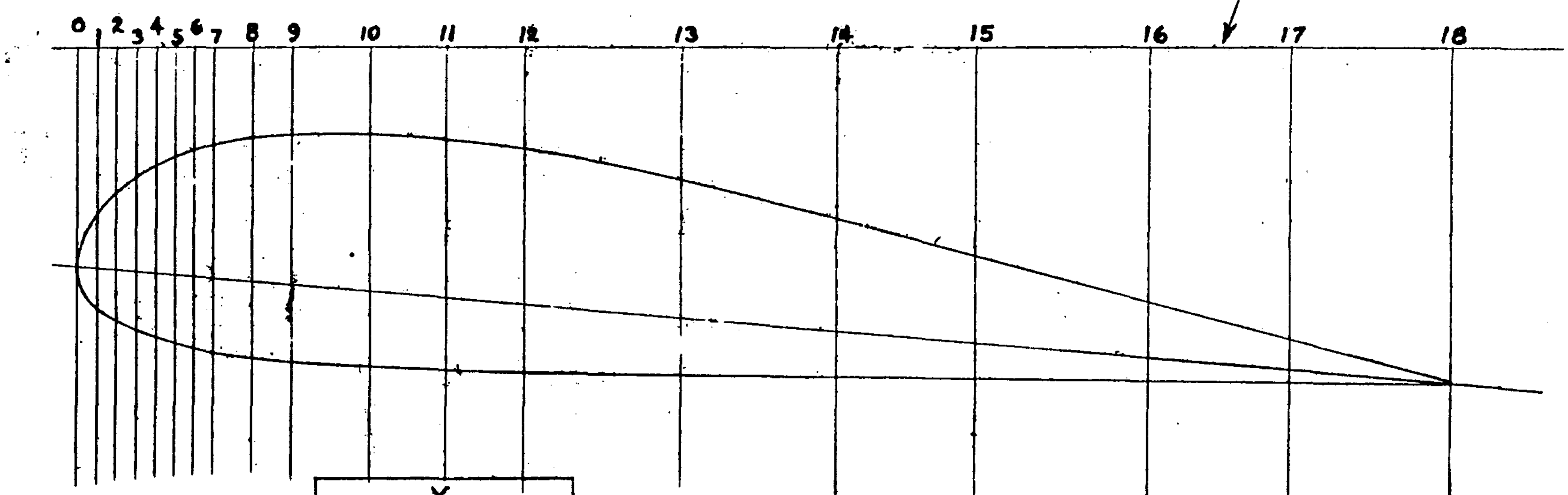

PITCHING MOMENT VARIATION DUE TO SHORT CHANNEL
AND SHORT CHORD AUXILIARY WING
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
TEST NO. 545
WRIGHT FIELD
APRIL AND MAY 1946
SHORT CHANNEL, 75" CHORD
CHANNEL END PLATES ON
AUX. WING MOUNTING PLATES ON
2 BLADE THICK HUB WOODEN PROP
β=20° @ 75%
C.R. 12" AFT T.E.
○ RIGHT PANELS @ 40°, LEFT @ 30°
△ RIGHT PANELS @ 40°, LEFT @ 25°
□ RIGHT PANELS @ 40°, LEFT @ 35°
◇ RIGHT PANELS @ 50°, LEFT @ 35°
BIPLANE AUX. WINGS
4 PANELS 15" X 28"
UPPER C.R. ON T.L.
LOWER C.R. 8" BELOW T.L.
+ SAME AS ◇ BUT LOWER C.R. 5" BELOW T.L.
X BIPLANE AUX. WINGS, UPPER PANEL 15" X 28", LOWER PANEL 29" X 35½", BOTH ON LEFT SIDE @ 35°, UPPER C.R. 1" BELOW T.L., LOWER C.R. 7" BELOW T.L.
✱ MONOPLANE AUX. WING, ONE PANEL 29" X 35½", ON LEFT SIDE @ 40°, C.R. 7" BELOW T.L.
PITCHING MOMENT / H.P. ∽ FT. LB. / H.P.
H.P. / DIAMETER 2
GRAPH 24



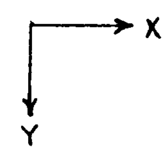
THRUST VARIATION DUE TO TYPE OF PROPELLER, BLADE ANGLE,
AND PROPELLER HUB FAIRINGS
CUSTER CHANNEL WING
5 FT. WIND TUNNEL
WRIGHT FIELD
TEST NO. 545
MAY 1946
CHANNEL WING OFF
2 BLADE THICK HUB WOODEN PROP.
3 BLADE WIDE TIP METAL PROP
β = 6° @ 90%
β = 11.1°
β = 21.1°
β = 31.1°
β = 11.1°
β = 21.1°
β = 16.1°
8 5/8" DIA X 3 5/8" CHORD CYLINDRICAL DISC OVER PROP HUB
β = 16.1°, DISC ON STREAMLINE NOSE FAIRING ON
β = 16.1°, DISC ON NOSE FAIRING ON, CONICAL SPINNER ON
THRUST / H.P. ~ LB./HP
H.P./DIAMETER²
GRAPH 25


PRESSURE DISTRIBUTION OVER CUSTER CHANNEL WINGS
5-FT. WIND TUNNEL
WRIGHT FIELD
TEST NO. 545
MAY, 1946
O CONDITION 25 -- LONG CHANNEL, 43" CHORD, 2-BLADE WOOD PROP, β = 20° @ 75 %
H.P./DIA.² = .865, RPM = 2497
Δ CONDITION 53 -- SHORT CHANNEL, 17.5" CHORD, 2-BLADE WOOD PROP, β = 8° @ 75 %
H.P./DIA.² = .480, RPM. = 2391
NOTE: PRESSURE IS
BELOW ATMOSPHERIC
GRAPH 26
PRESSURE —— INCHES OF WATER
WING STATION —— PERCENT CHORD
0
.4
.8
1.2
1.6
0
10
20
30
40
50
60
70
80
90
100

5568



STATION	X	Y UPPER	Y LOWER
0	0	2.824	2.824
1	.250	2.147	3.368
2	.500	1.880	3.520
3	.750	1.676	3.634
4	1.000	1.529	3.721
5	1.250	1.421	3.805
6	1.500	1.326	3.862
7	1.750	1.249	3.916
8	2.250	1.161	3.985
9	2.750	1.124	4.038
10	3.750	1.124	4.110
11	4.750	1.204	4.170
12	5.750	1.288	4.201
13	7.750	1.707	4.216
14	9.750	2.192	4.240
15	11.750	2.683	4.266
16	13.750	3.194	4.275
17	15.750	3.733	4.285
18	17.571	4.297	4.337



NOTE:
DRAWING IS 1/2-SIZE
DIMENSIONS ARE FULL SIZE

SKETCH NO. 1
CUSTER CHANNEL WING
17.5-INCH CHORD

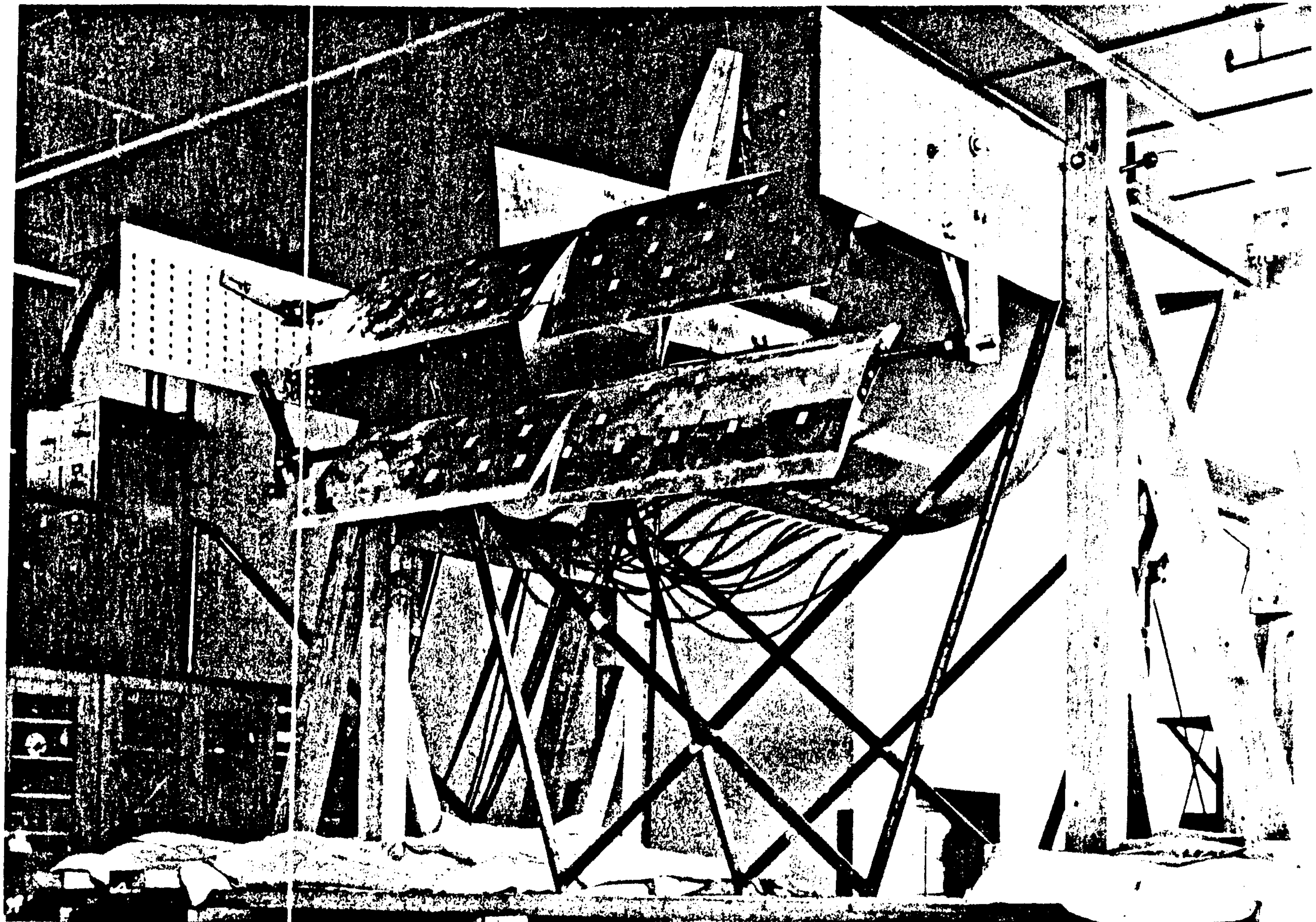


Photo 208370 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust, Chordwise Pressure Distribution, and Power, Wing Condition No. 25, 43 Inch Chord Channel, R. H. Lower 3/4 Rear Close-Up

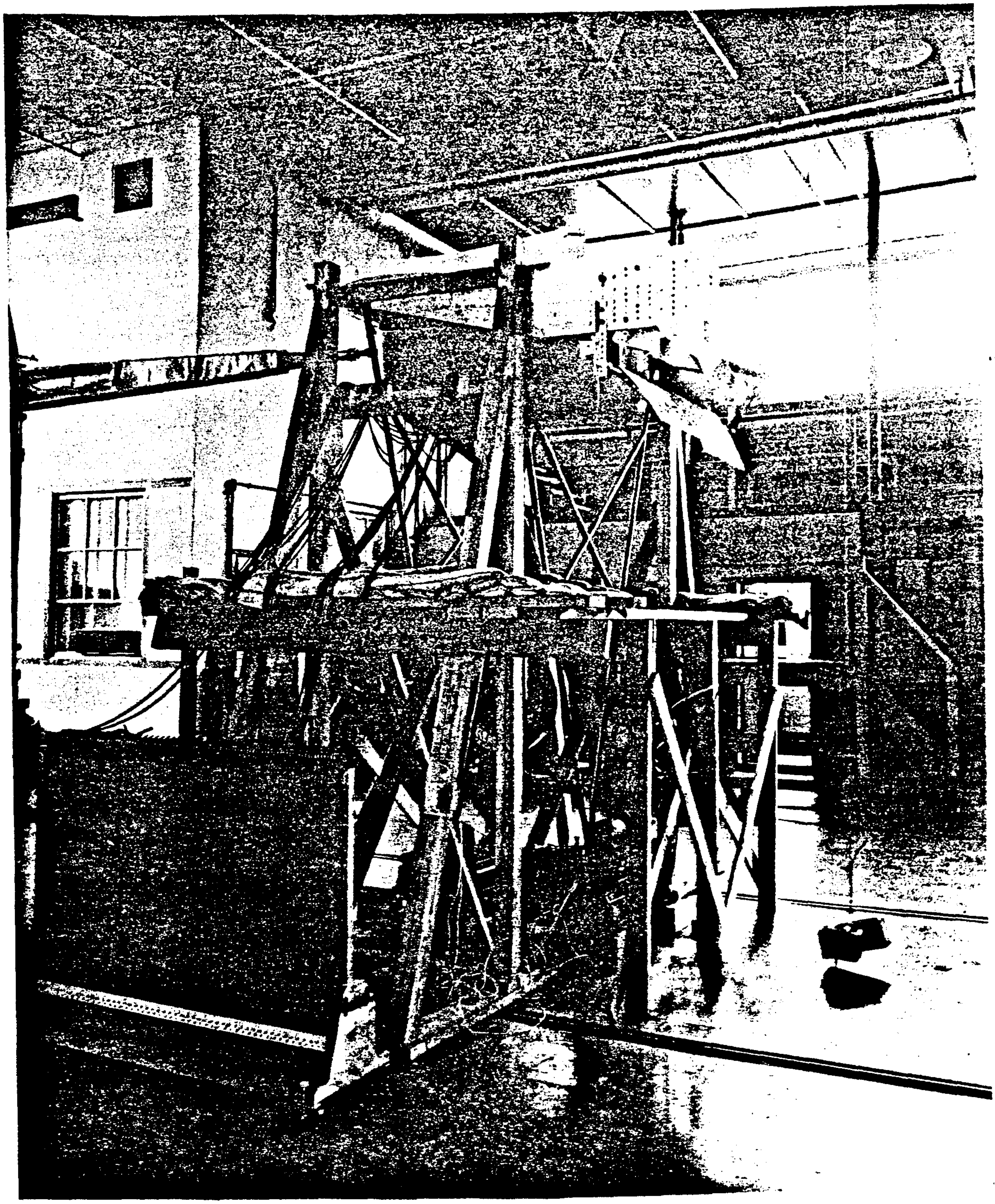


Photo 208371 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust, Chordwise Pressure Distribution, and Power, Wing Condition No. 25, 43 Inch Chord Channel, L. H. Rear 3/4 View

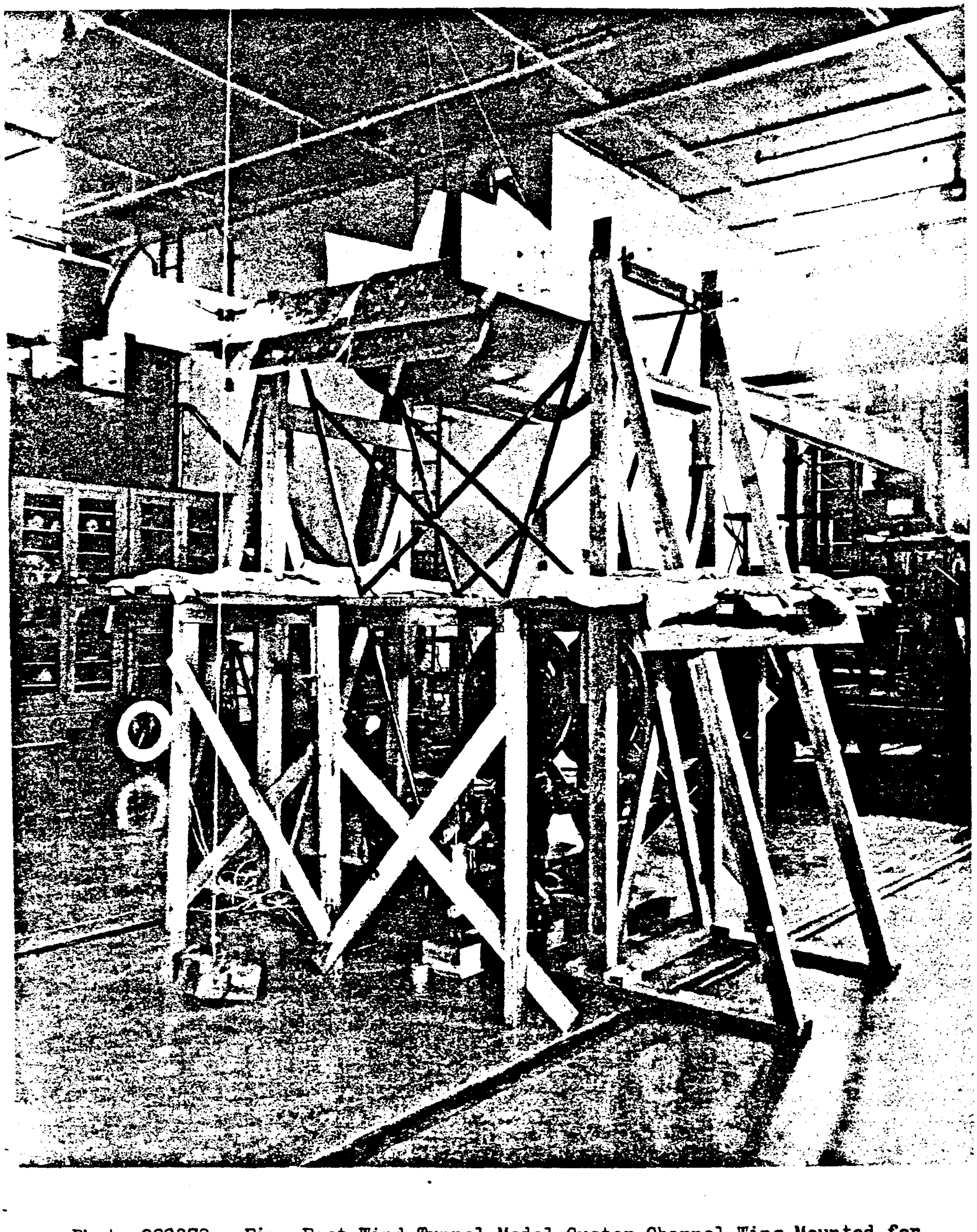


Photo 208372 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust, and Power, Wing Condition No. 12, 43 Inch Chord Channel, R. H. 3/4 Rear View

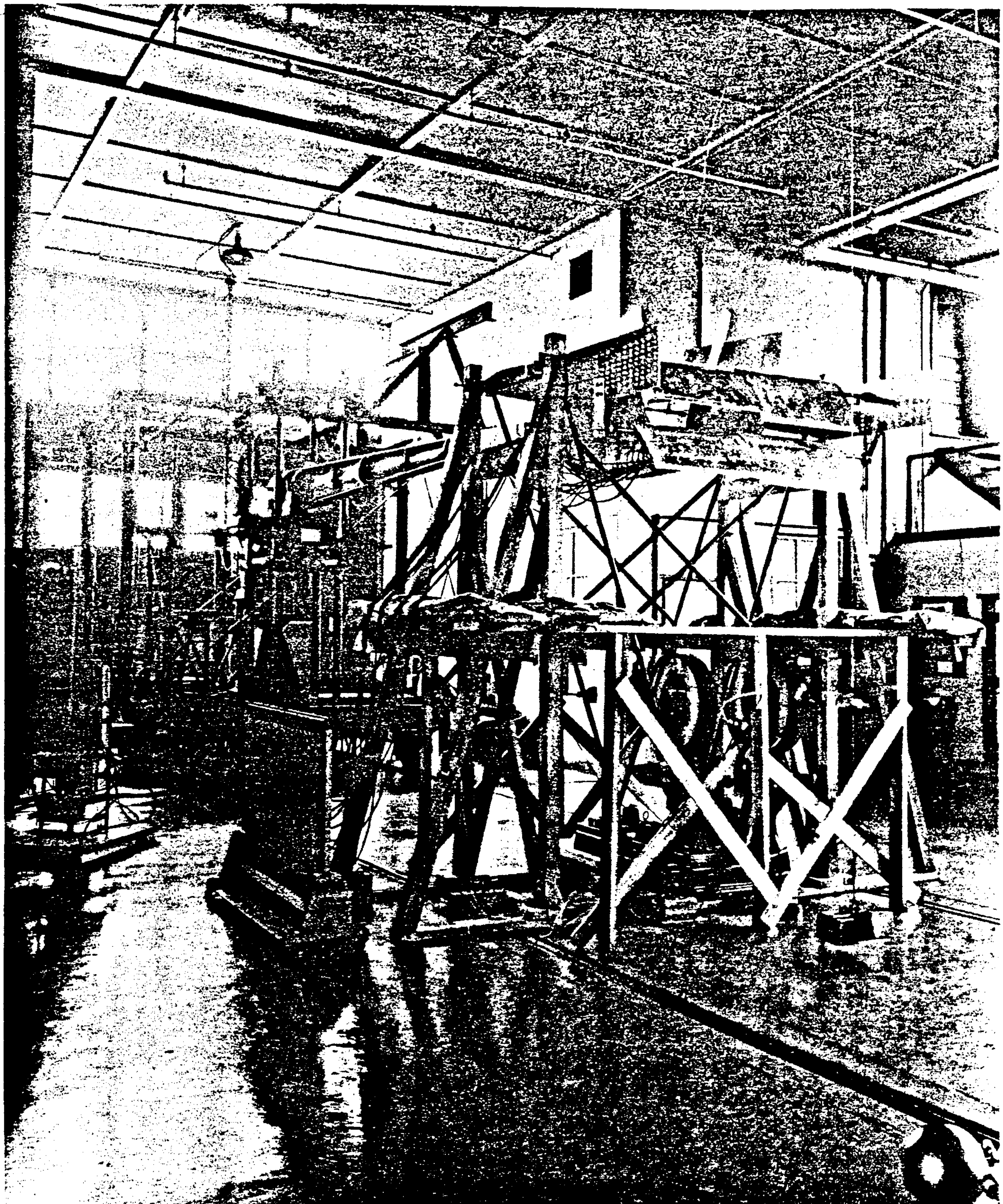


Photo 208373 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust, Chordwise Pressure Distribution and Power, Wing Condition No. 25, 43 Inch Chord Channel, L. H. 3/4 Rear View

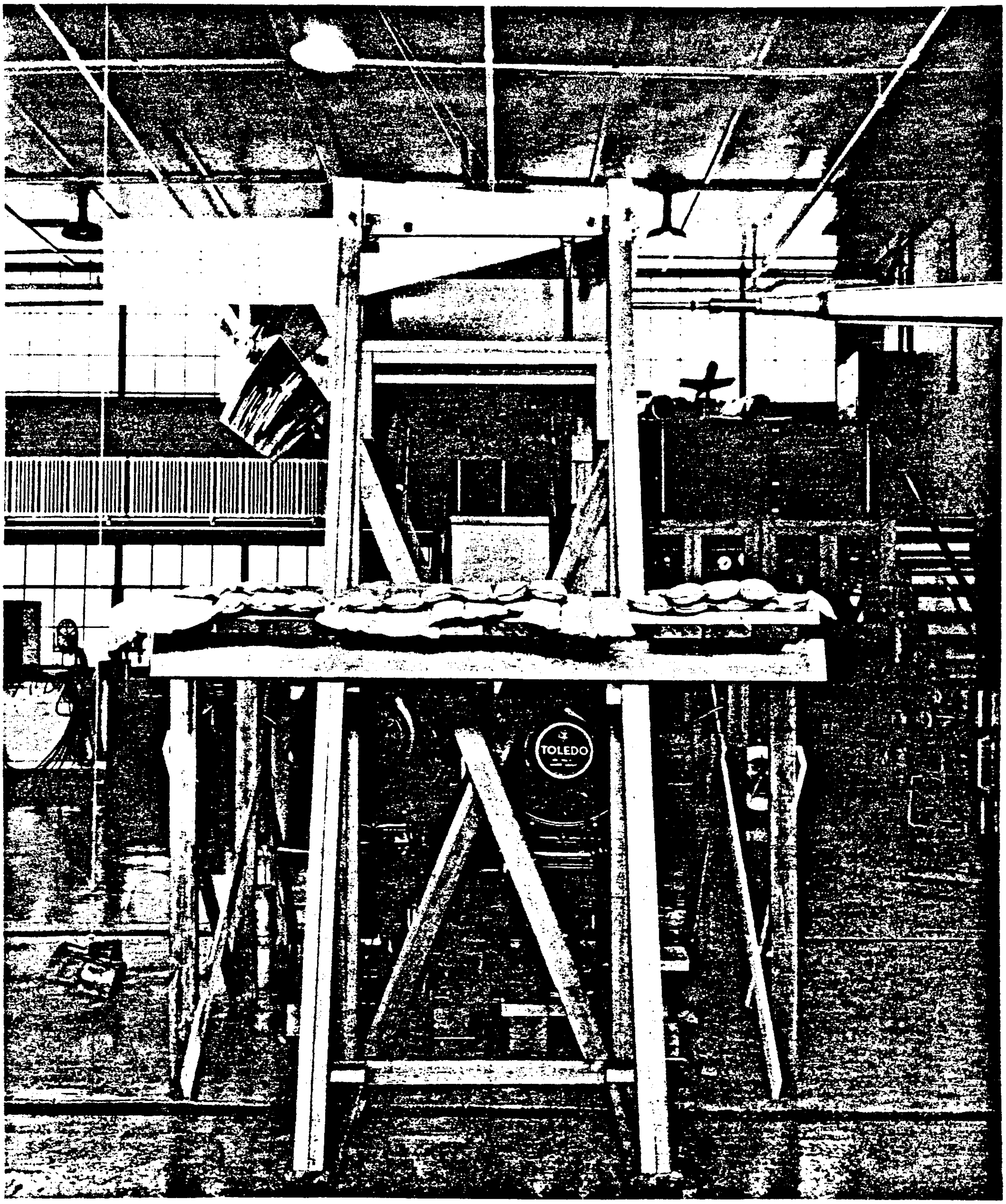


Photo 208374 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 24, 43 Inch Chord Channel, R. H. Side View

5568

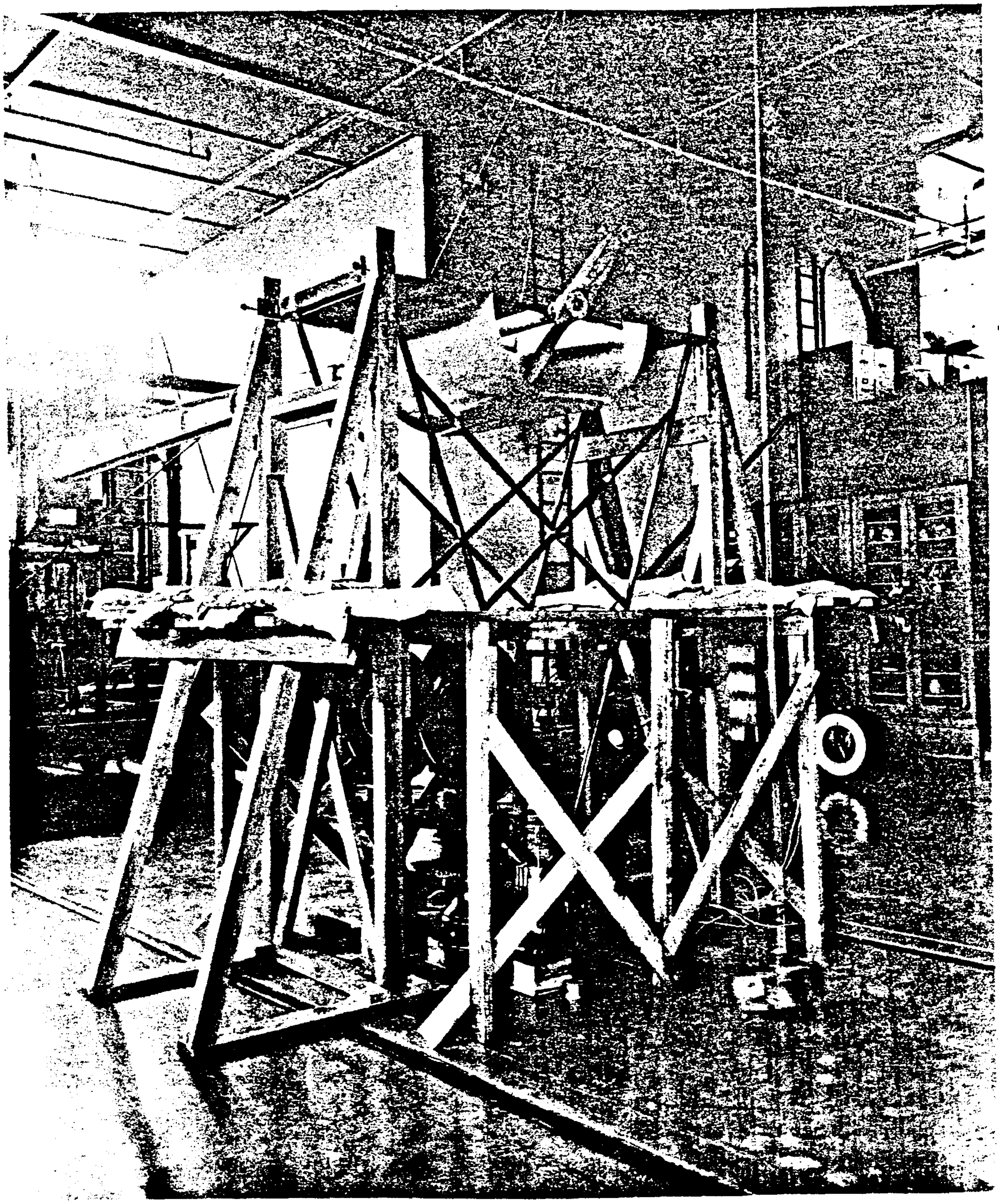


Photo 208375 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 3, 43 Inch Chord Channel, R. H. 3/4 Rear View

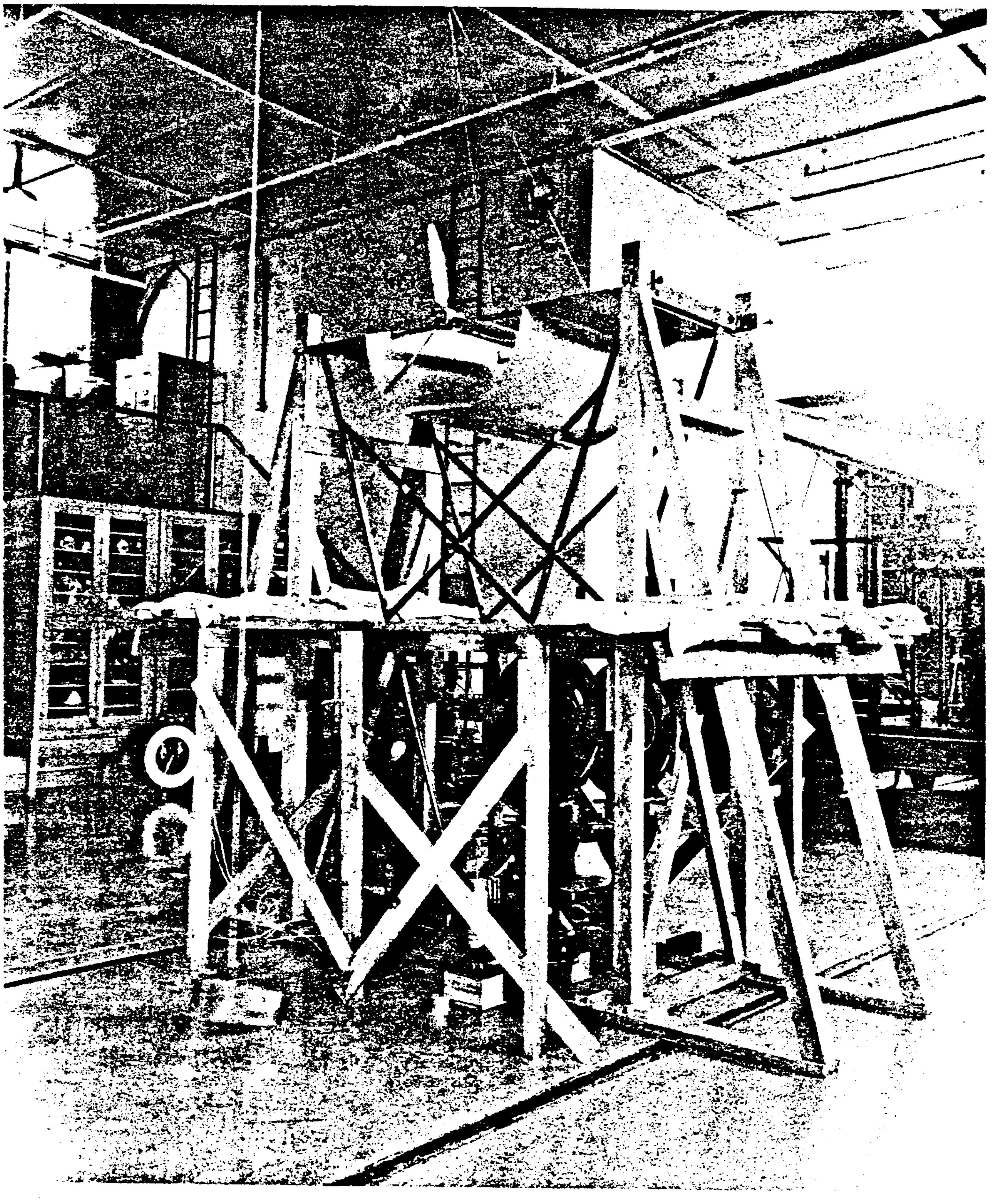


Photo 208376 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 1
43 Inch Chord Channel, R. H. 3/4 Rear View

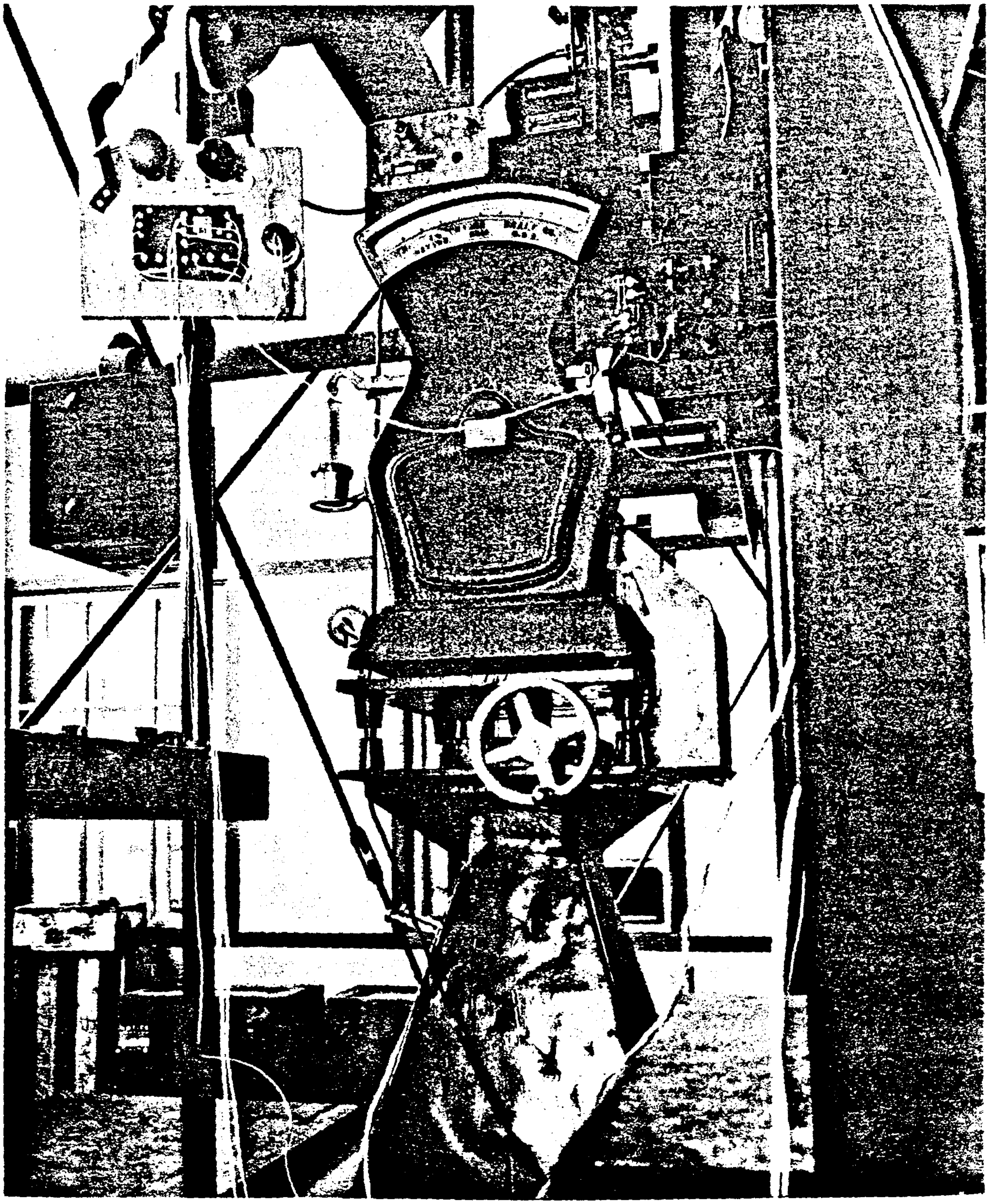


Photo 208377 - Scale Arrangement for Obtaining Thrust, During Static Lift, Thrust and Power Tests on 43 Inch Chord Custer Channel Wing

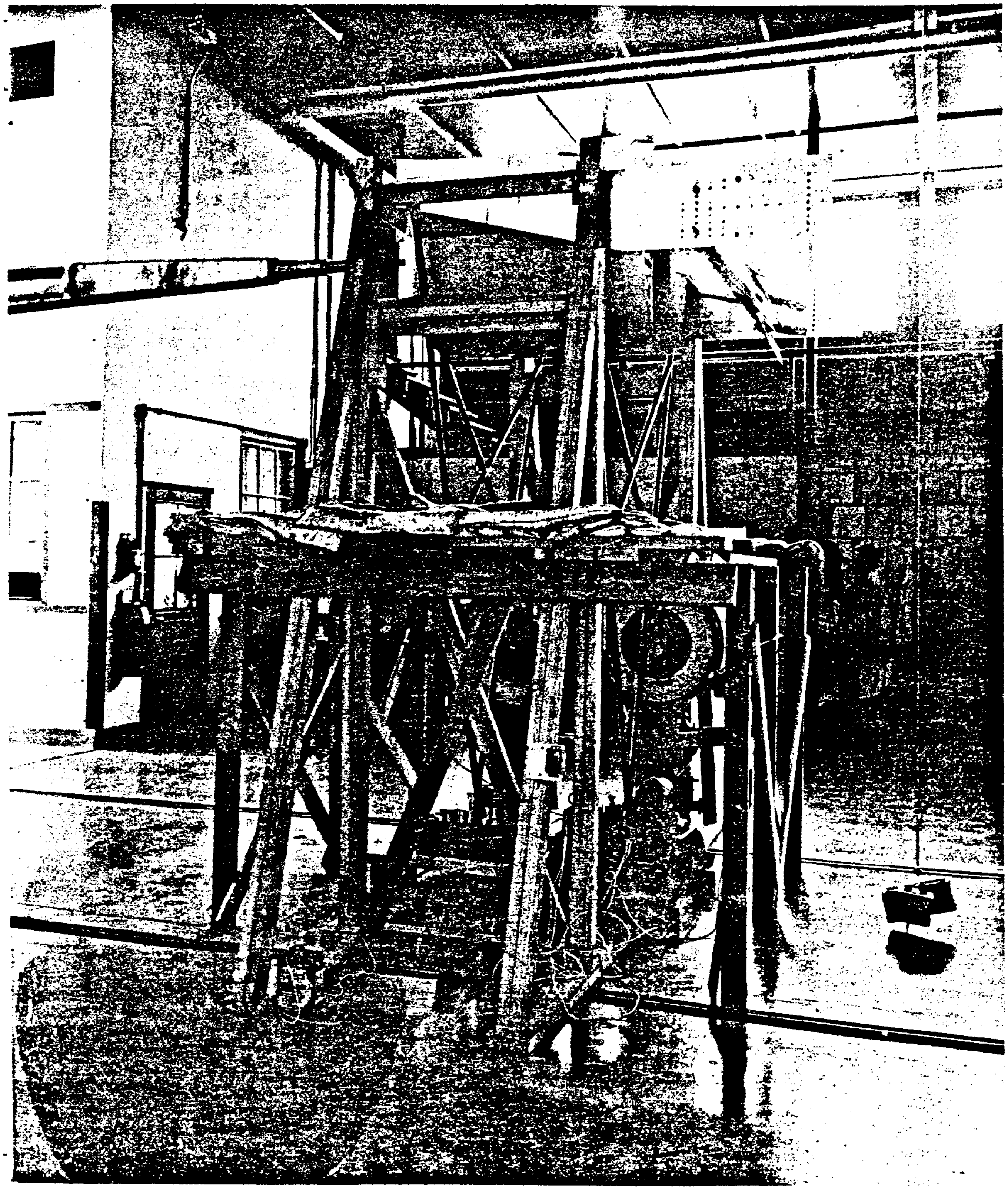


Photo 208378 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 12, 43 Inch Chord Channel, L. H. Side View

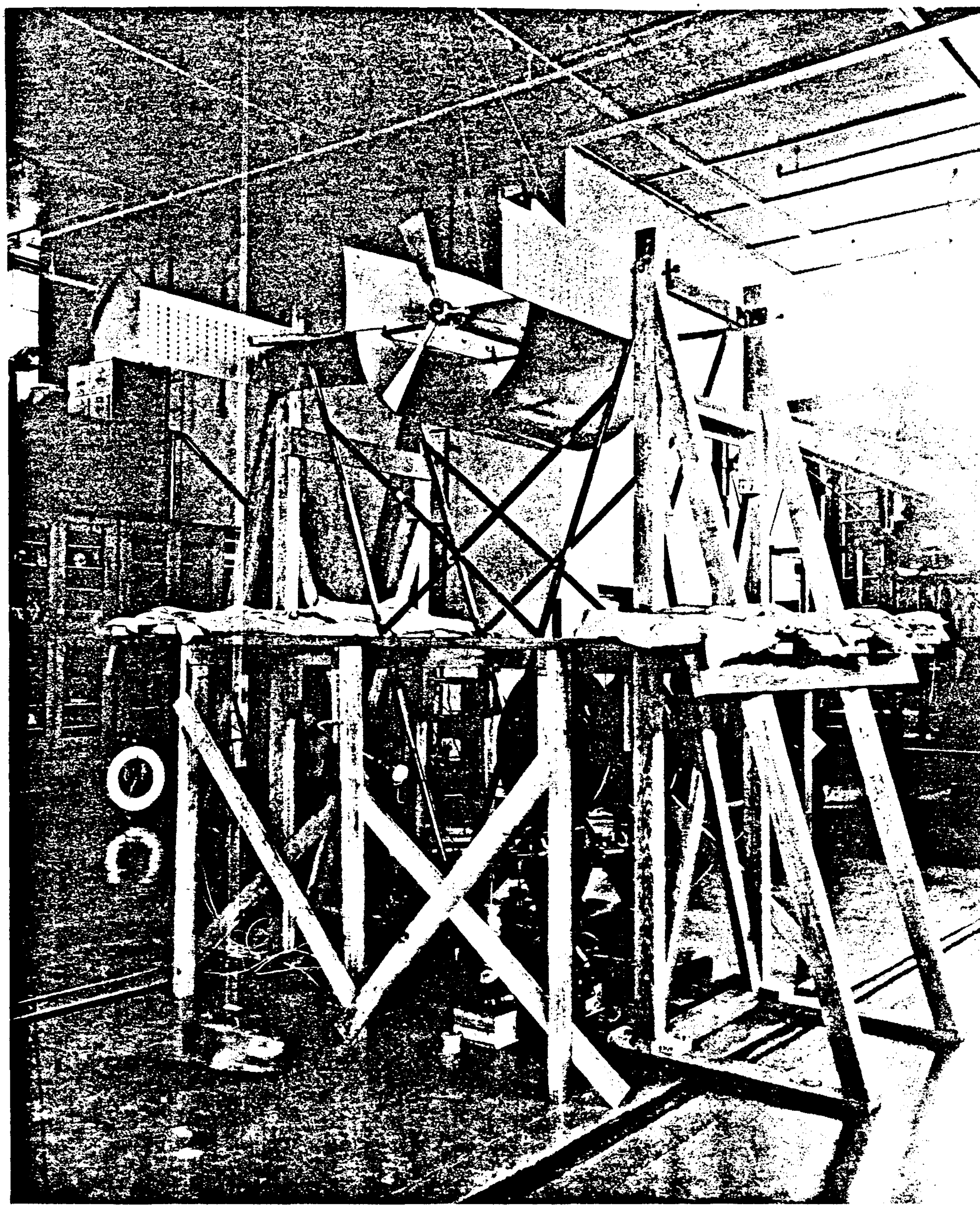


Photo 208379 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 13, 43 Inch Chord Channel, R. H. 3/4 Rear View

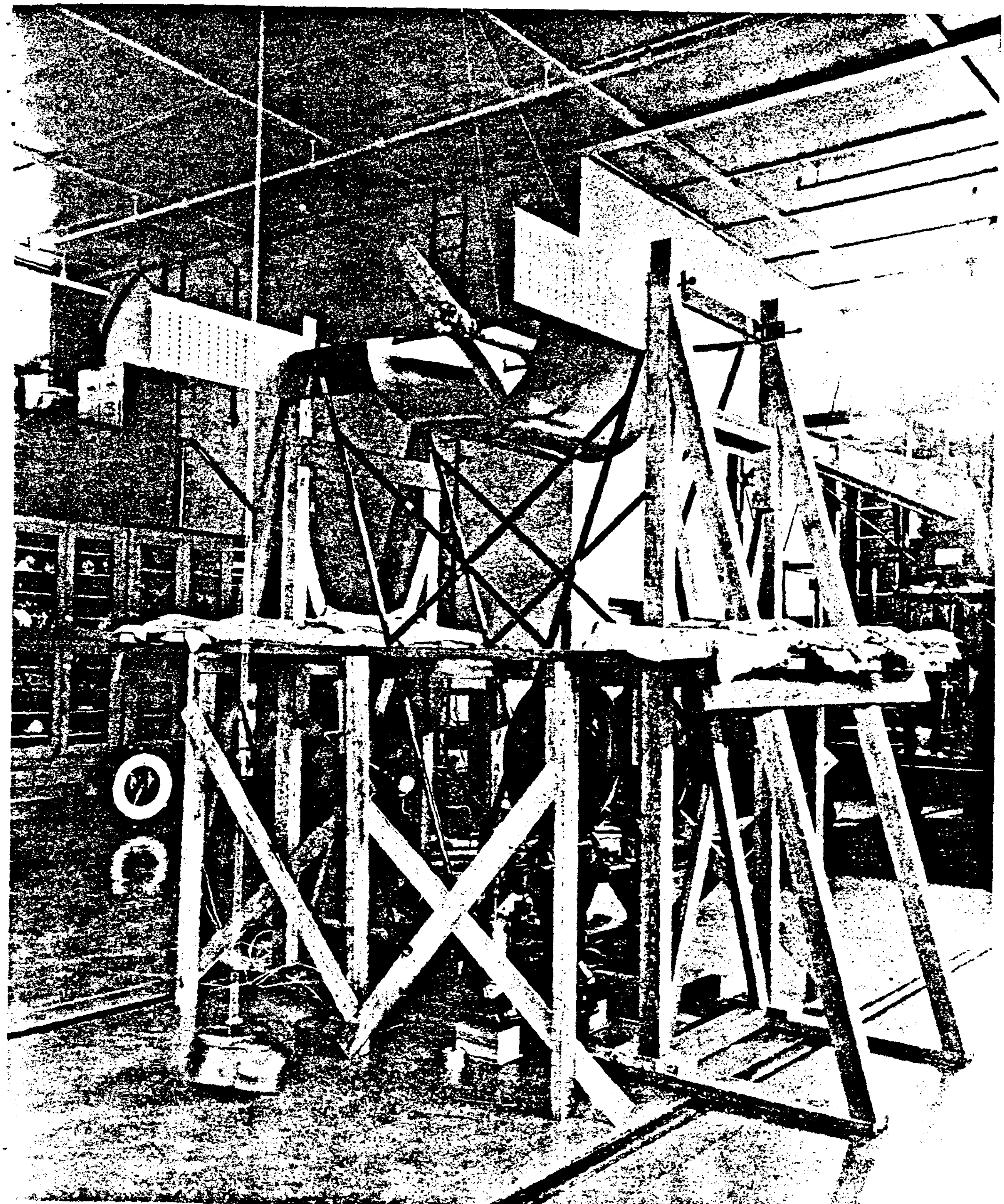


Photo 208380 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 5, 43 Inch Chord Channel, R. H. 3/4 Rear View

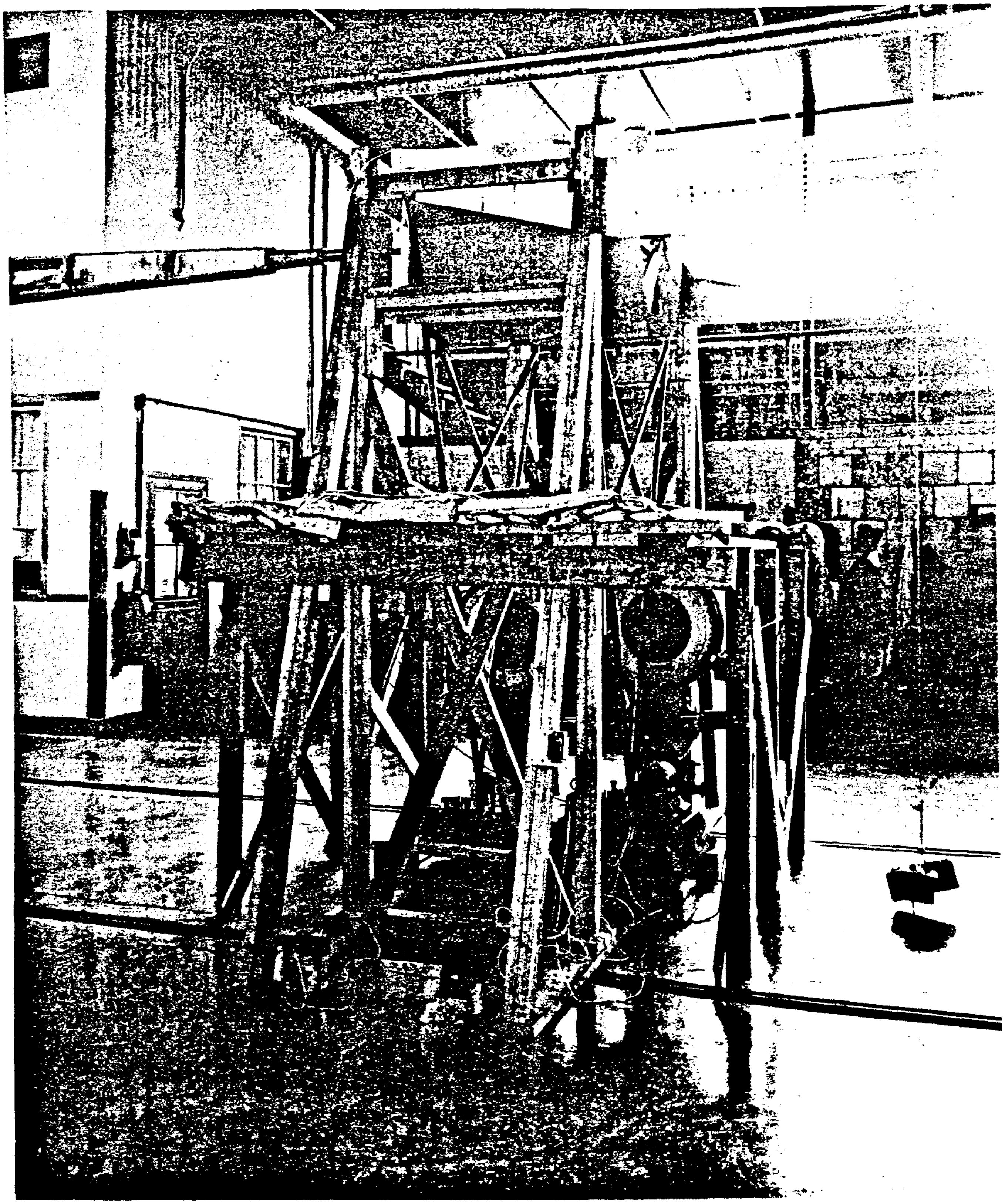


Photo 208381 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 13, 43 Inch Chord Channel, L. H. Side View

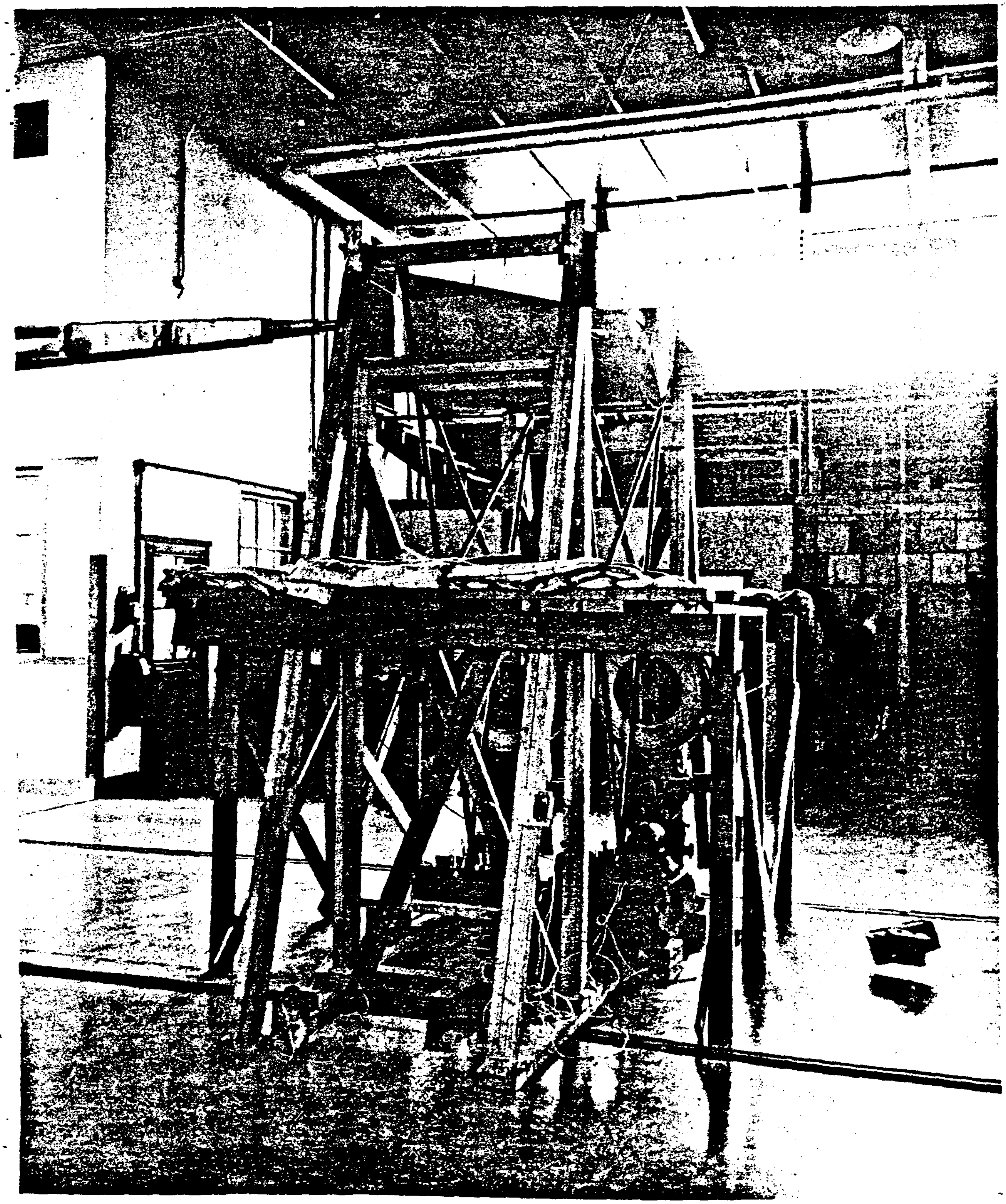


Photo 208382 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 5, 43 Inch Chord Channel, L. H. Side View

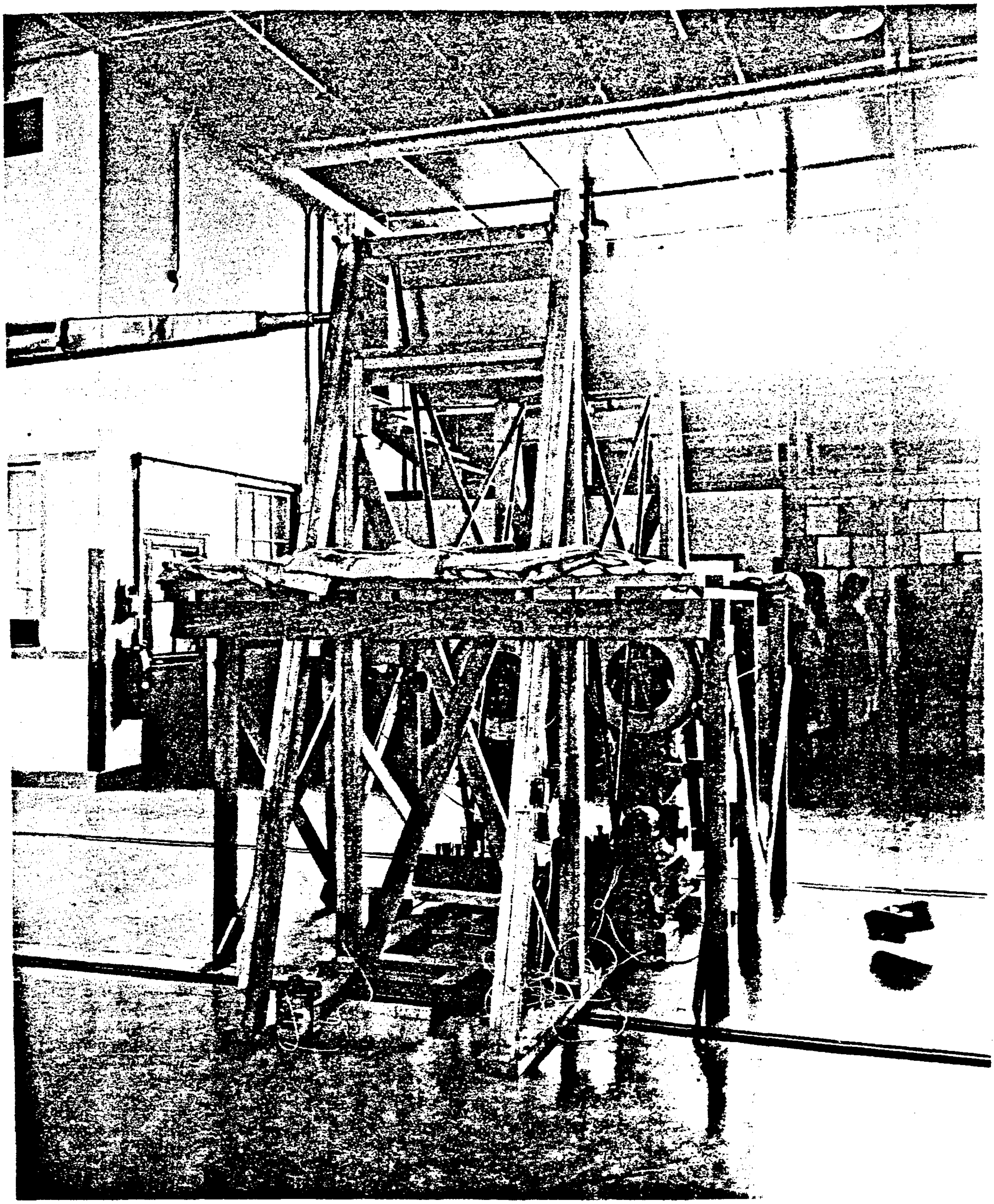


Photo 208383 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 3, 43 Inch Chord Channel, L. H. Side View

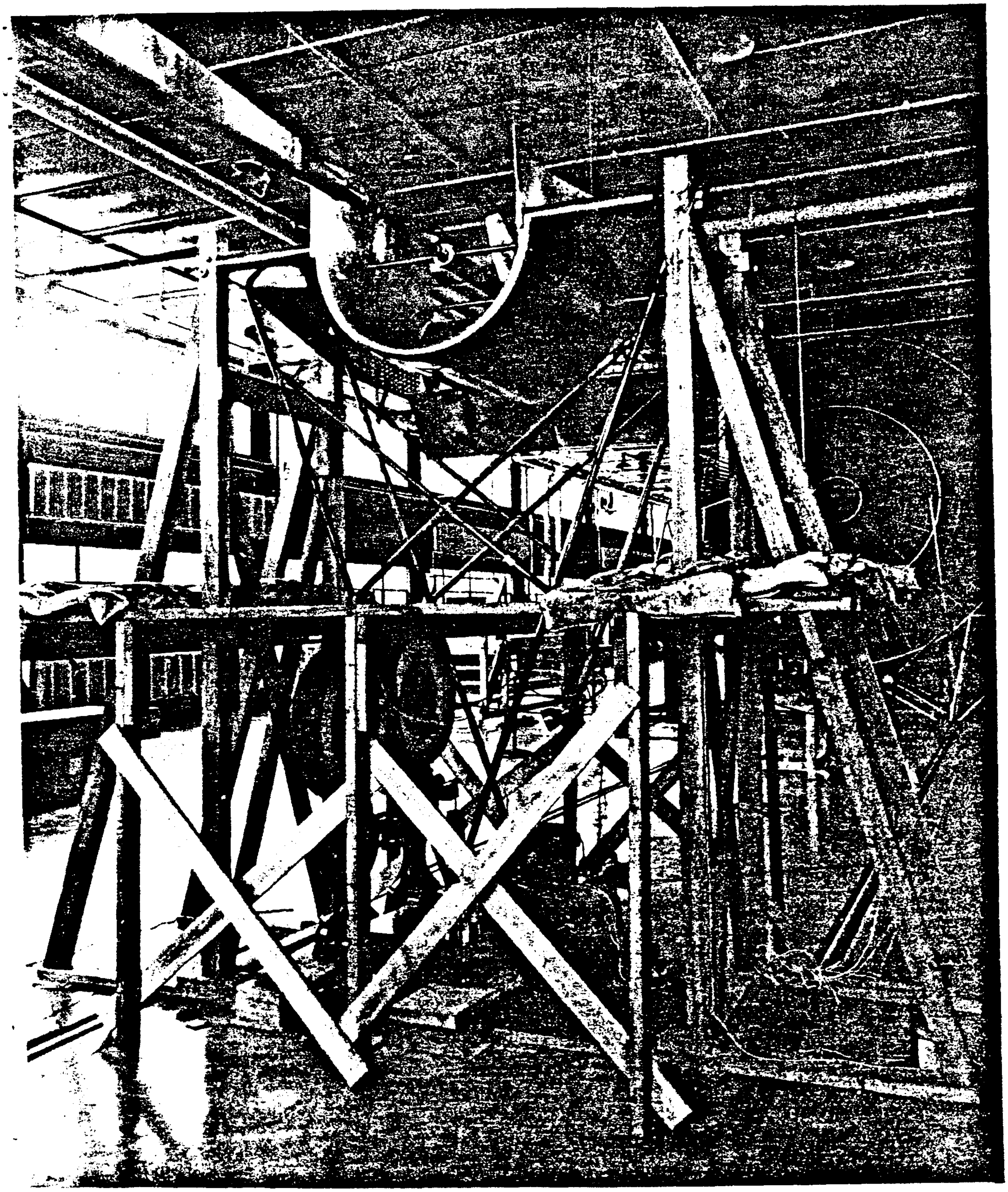


Photo 208384 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 24, 43 Inch Chord Channel, L. H. 3/4 Front View

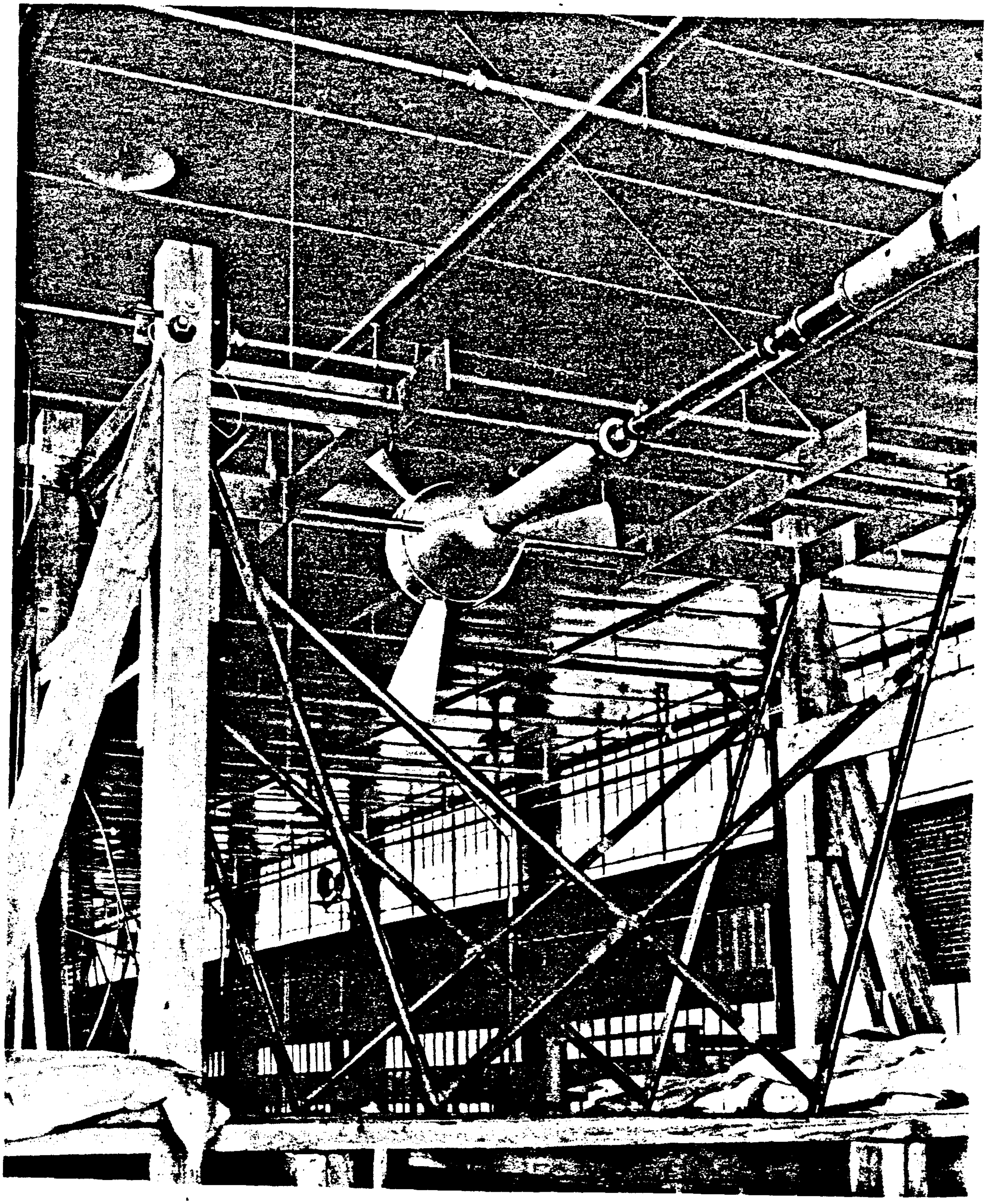


Photo 209513 - Five-Foot Wind Tunnel Set-Up for Obtaining Static Lift, Thrust and Power During Tests of Custer Channel Wing, Wing Condition No. 50, 3/4 Front View

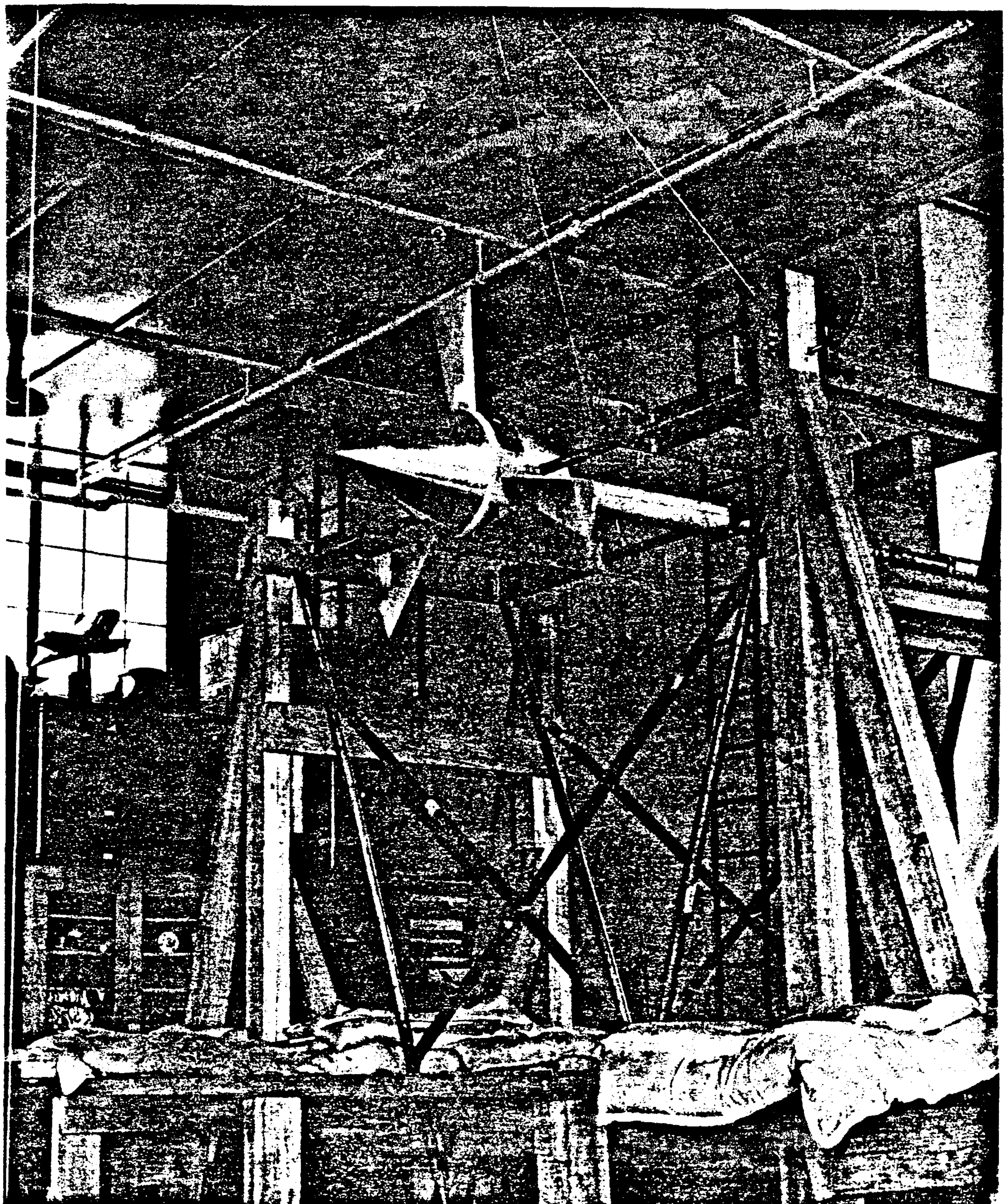


Photo 209514 - Five-Foot Wind Tunnel Set-Up for Obtaining Static Lift, Thrust and Power During Tests of Custer Channel Wing, Wing Condition No. 50, 3/4 Rear View

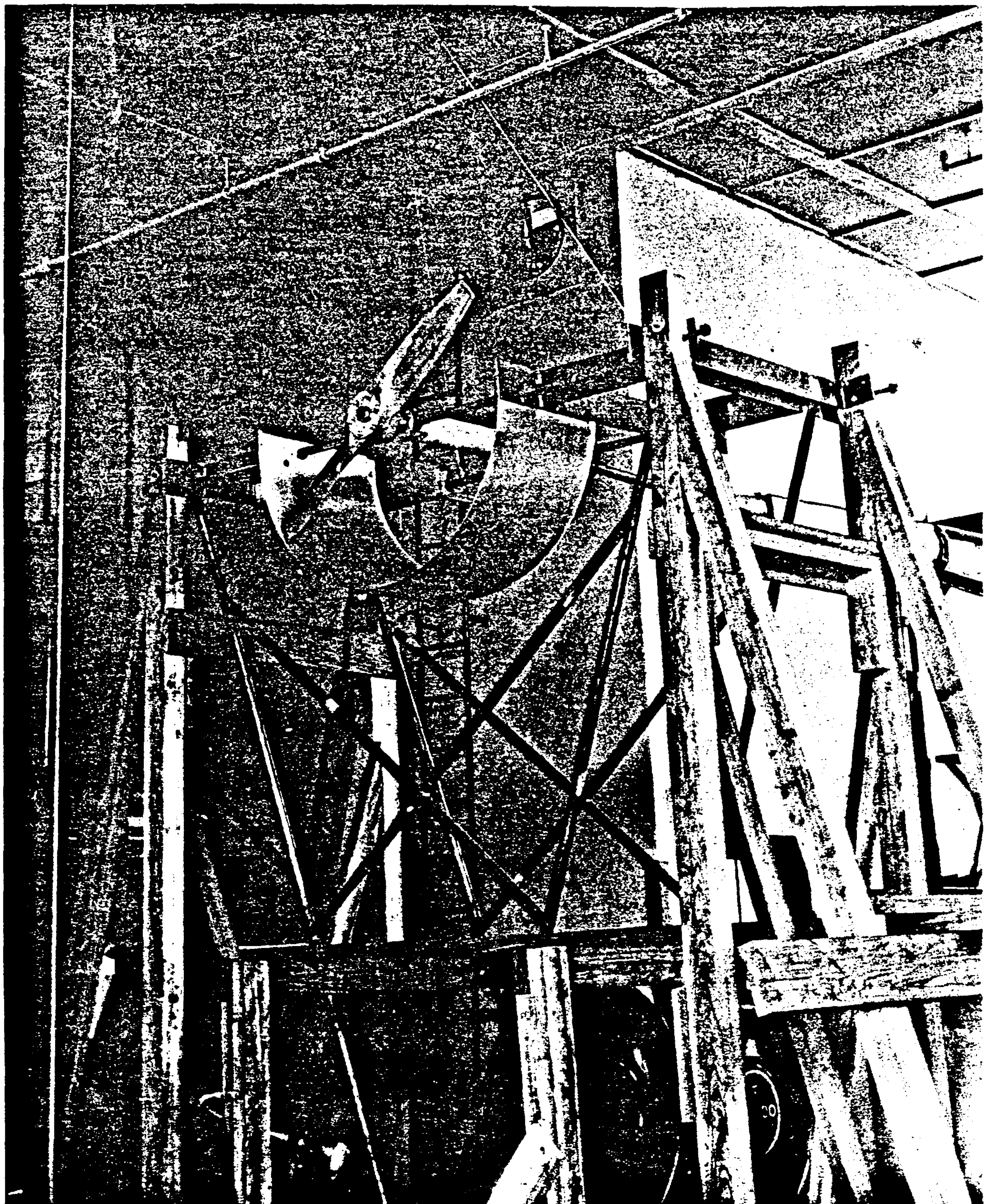


Photo 211042 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 53, 17.5 Inch Chord Channel, 3/4 Rear View

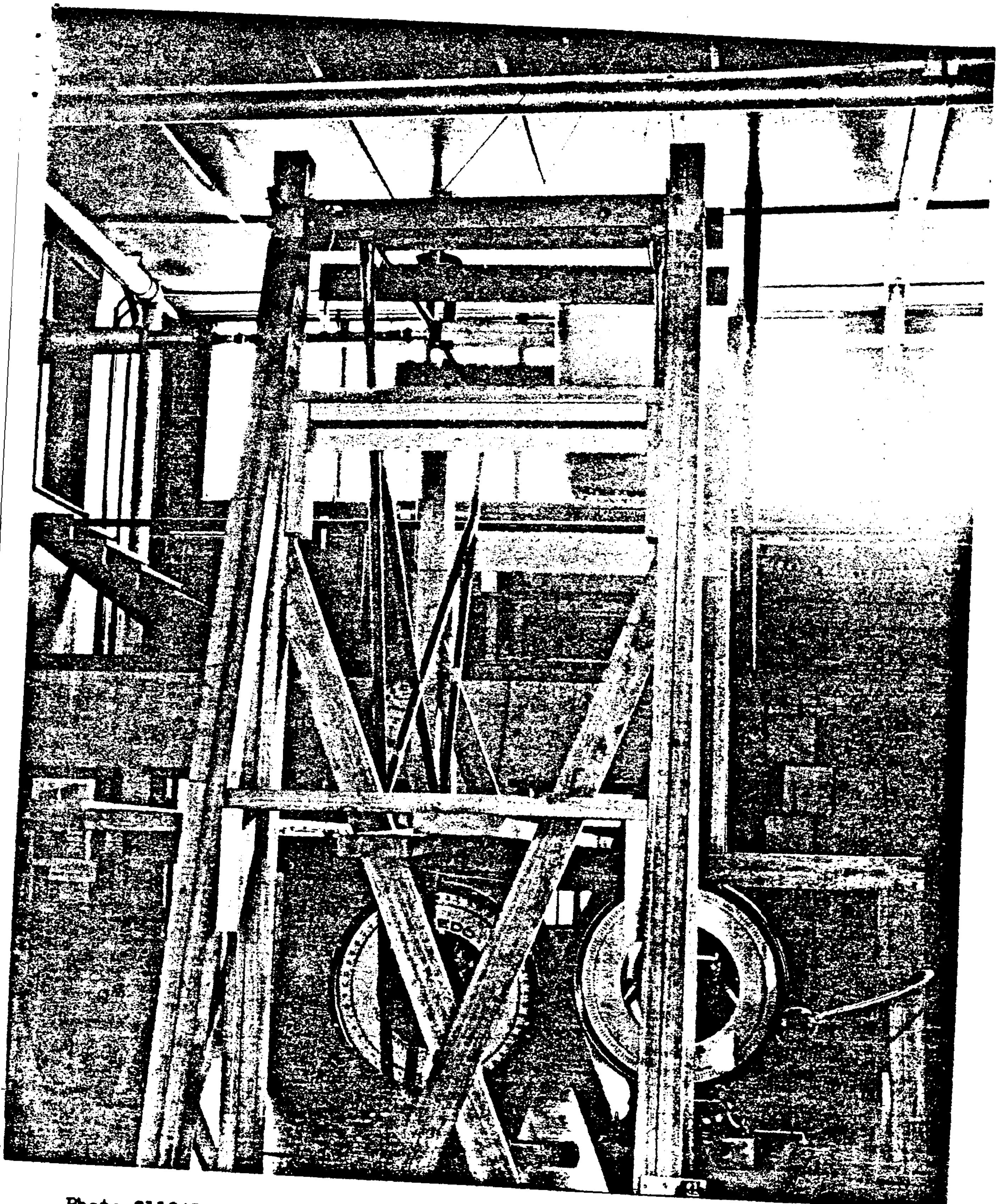


Photo 211043 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 53, 17.5 Inch Chord Channel, Side View

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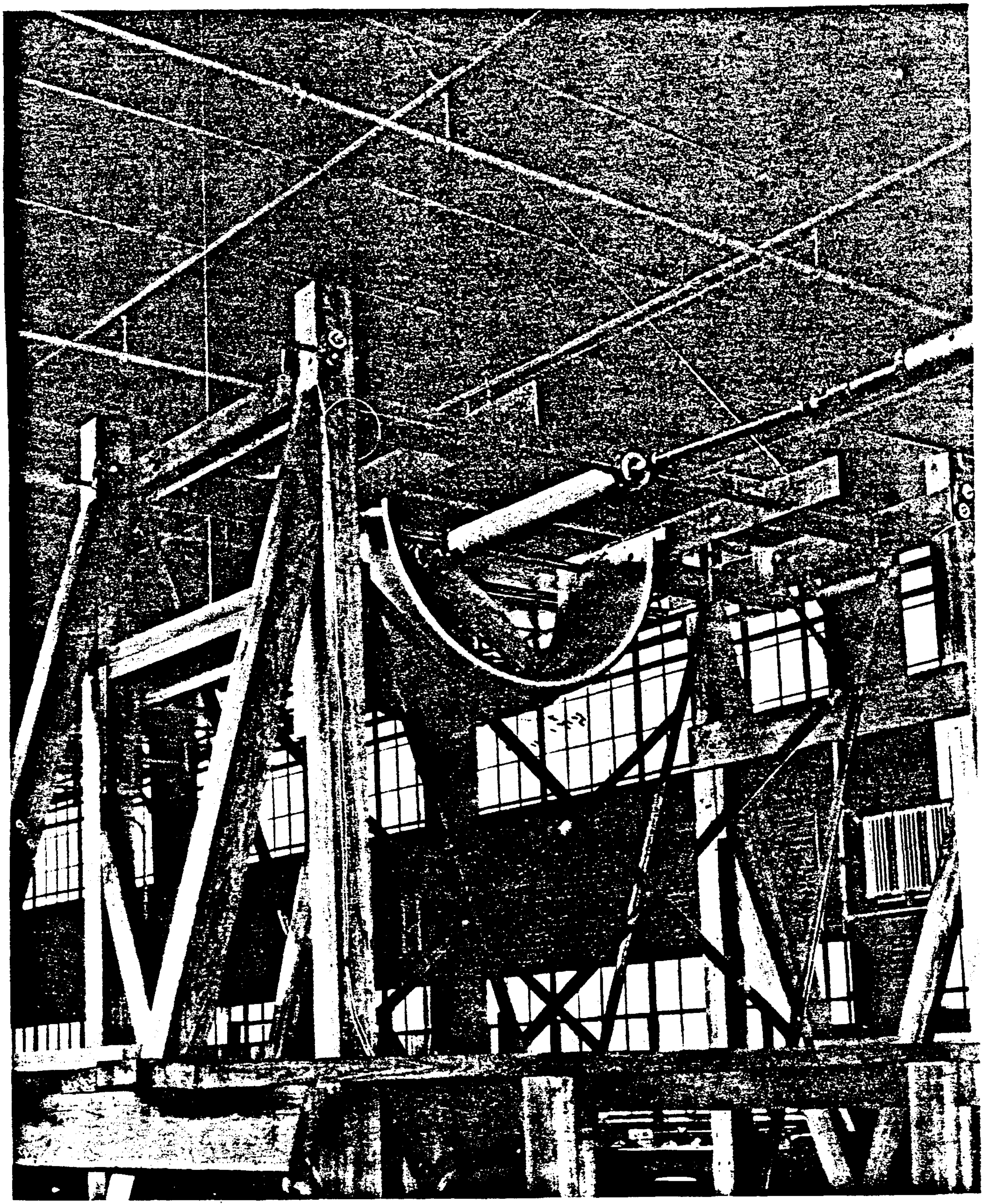

Photo 211044 - Five-Foot Wind Tunnel Model Custer Channel Wing Mounted for Obtaining Static Lift, Thrust and Power, Wing Condition No. 53, 17.5 Inch Chord Channel, 3/4 Front View

STANDARD SYMBOLS, DEFINITIONS, AND AIRPLANE AXES

Forces and Moments (Continued from inside of front cover)

$C_L = L/qS$ lift coefficient
L lift
$C_D = D/qS$ drag coefficient
D drag
Section coefficients are lower case:
c_l, lift; c_d, drag; etc.
$C_Y = Y/qS$ lateral force coefficient
Y lateral force
$C_m = M/qcS$ pitching-moment coefficient
M pitching moment

$C_n = N/qbS$ yawing-moment coefficient
N yawing moment
$C_l = L/qbS$ rolling-moment coefficient
L rolling moment
$C_h = H/qS\bar{c}$ hinge-moment coefficient
where
H hinge moment
S area of hinged surface back of hinge line
$\bar{c}$ root-mean-square chord back of hinge line

General Aerodynamic Symbols

M. A. C. mean aerodynamic chord
c. g. center of gravity.
b span
S area
c chord
A aspect ratio (b^2/S)
W weight
m mass (W/g)
g acceleration of gravity
I moment of inertia (mk^2). Indicate radius of gyration k by proper subscript, k_X, k_Y, k_Z
α angle of attack of reference line in plane of symmetry
δ angle of control surface relative to neutral position.
Add subscript for surface, δ_a, aileron; δ_r, rudder, etc.
i_w angle between wing reference line and reference line in plane of symmetry (usually the thrust line)
i_t angle of stabilizer relative to reference line in plane of symmetry (usually the thrust line)
V airspeed
a velocity of sound
M Mach number (V/a)
l linear dimension
μ coefficient of viscosity
ρ density (mass per unit volume). Density of dry air at 15°C and 29.92 in. Hg is 0.002378 lb.-ft.$^{-4}$sec.^{2}
ν kinematic viscosity (μ/ρ). For standard air, 1.564×10^{-4} ft.^{2}/sec.
R Reynolds number (Vl/ν)
q dynamic pressure ($\frac{1}{2}\rho V^2$)
q_c impact pressure ($\frac{1}{2}\rho V^2 F_c$)

F_c compressibility factor ($1+\frac{1}{4}M^2+\ldots$)
p static pressure
p_o pressure in free stream
H total pressure (tunnel)
p_T total pressure (flight)
P pressure coefficient $\left(\dfrac{p-p_o}{\frac{1}{2}\rho V^2}\right)$
T absolute temperature

Propeller Symbols

D propeller diameter
r propeller radius
p propeller pitch
p/D pitch ratio
n revolutions per second
J advance-diameter ratio (V/nD)
β propeller blade angle at designated radius
ϕ effective helix angle ($\tan^{-1} V/2\pi rn$)
η efficiency
$C_P = P/\rho n^3D^5$ power coefficient
P power
$C_Q = Q/\rho n^2D^5$ torque coefficient
Q torque
$C_s = \sqrt[5]{\dfrac{\rho V^5}{Pn^2}}$ speed-power coefficient
T propeller thrust, crankshaft tension
ΔD drag increase due to propeller slipstream
T_e effective propeller thrust ($T - \Delta D$)
$C_T = T/\rho n^2D^4$ thrust coefficient
$T_c = T/\rho V^2D^2$ thrust disk-loading coefficient
$T_c' = T_e/qS$ effective thrust coefficient based on wing area
$Q_c = Q/\rho V^2D^3$ torque coefficient

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ABSTRACT

Tests were made to determine the resultant force in pounds hp obtainable with Custer channel wing (a wing-propeller arrangement). Fifty-three different model configurations were used in two different length channels, with two- and three-bladed propellers of various planforms and blade angles. The resultant of the thrust and lift forces was greater for the short channel than for the long one. The normal blade planform was slightly better than reverse taper planform.

Aerodynamics Slots (143) (25) Channel Wings

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...e originating agency, in which case a corresponding note ...e abstract on the catalog card.

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